Systematic Revision of the Andean Scorpion Genus *Orobothriurus* Maury, 1976 (Bothriuridae), with Discussion of the Altitude Record for Scorpions

José A. Ochoa, Andres A. Ojanguren Affilastro, Camilo I. Mattoni, and Lorenzo Prendini

Bulletin of the American Museum of Natural History

SYSTEMATIC REVISION OF THE ANDEAN SCORPION GENUS *OROBOTHRIURUS* MAURY, 1976 (BOTHRIURIDAE), WITH DISCUSSION OF THE ALTITUDE RECORD FOR SCORPIONS

JOSÉ A. OCHOA[1,2]
ANDRES A. OJANGUREN AFFILASTRO[3]
CAMILO I. MATTONI[4]
LORENZO PRENDINI[1]

[1]*Scorpion Systematics Research Group, Division of Invertebrate Zoology, American Museum of Natural History, Central Park West at 79th Street, New York, NY, 10024-5192*
[2]*Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, travessa 14, 101, São Paulo, SP, 05508-900, Brazil*
[3]*Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Avenida Ángel Gallardo 470, CP: 1405DJR, Buenos Aires, Argentina*
[4]*Laboratorio de Biología Reproductiva y Evolución, Cátedra de Diversidad Animal I, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Av. Vélez Sarsfield 299, 5000, Córdoba, Argentina*

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY
Number 359, 90 pp., 54 figures, 3 tables
Issued November 23, 2011

Copyright © American Museum of Natural History 2011 ISSN 0003-0090

CONTENTS

Abstract 3
Introduction 3
Material and Methods 5
On the distribution of *Orobothriurus* 8
On the altitude record for Scorpiones 11
Systematics 12
Orobothriurus (Maury, 1976) 12
Key to identification of the species of *Orobothriurus* 14
Orobothriurus alticola (Pocock, 1899) 15
Orobothriurus ampay Ochoa and Acosta, 2003 20
Orobothriurus atiquipa Ochoa and Acosta, 2002 25
Orobothriurus calchaqui, n. sp. 25
Orobothriurus compagnuccii, n. sp. 41
Orobothriurus curvidigitus (Kraepelin, 1911) 48
Orobothriurus famatina Acosta, 2001 52
Orobothriurus grismadoi Ojanguren Affilastro et al., 2009 52
Orobothriurus huascaran, n. sp. 56
Orobothriurus paessleri (Kraepelin, 1911) 68
Orobothriurus parvus Maury, 1976 69
Orobothriurus quewerukana, n. sp. 70
Orobothriurus ramirezi, n. sp. 74
Orobothriurus tamarugal, n. sp. 77
Orobothriurus wawita Acosta and Ochoa, 2000 81
Acknowledgments 83
References 83
Appendix 1 88
Appendix 2 88

ABSTRACT

The systematics of the Andean scorpion genus, *Orobothriurus* Maury, 1976 (Bothriuridae Simon, 1880), is revised. New locality records, obtained during recent field expeditions, distribution maps, and a key to identification of the 15 known species, are provided. Six new species are described: *Orobothriurus calchaqui*, n. sp., from northwestern Argentina; *Orobothriurus compagnuccii*, n. sp., from the central Andes of Argentina; *Orobothriurus huascaran*, n. sp., from central Peru; *Orobothriurus quewerukana*, n. sp., from southern Peru and northern Chile; *Orobothriurus ramirezi*, n. sp., from central Chile; and *Orobothriurus tamarugal*, n. sp., from northern Chile. The known distribution of *Orobothriurus* and the altitude record for scorpions are discussed. The world's altitude record for a scorpion, previously reported as 5550 m, is demonstrated to be 4910 m.

INTRODUCTION

The genus *Orobothriurus* Maury, 1976, comprises several fairly small scorpion species from the high altitudes and arid zones of central-western and southern South America (figs. 1–4). The genus is endemic to the Andes Cordillera, extending from central Peru (Cordillera Blanca in Ancash Department) to central-western Argentina, including western Bolivia, northern and central Chile, and northern and western Argentina (fig. 1). The southernmost record is the El Nevado mountain range in Mendoza Province, Argentina (Ojanguren Affilastro et al., 2009; figs. 1, 3D, 54).

After its original description (Maury, 1976), this genus received little attention from taxonomists, mostly due to the scarcity of specimens in collections and the inaccessibility of the habitats where these scorpions occur, notably the high Andes Mountains, where each species is range restricted and microhabitat specific. This situation changed in recent years, as result of many expeditions conducted in the Andes of Argentina, Chile, and Peru, mostly by members of our research group.

Orobothriurus initially included eight species (Maury, 1976): *Orobothriurus alticola* (Pocock, 1899); *Orobothriurus curvidigitus* (Kraepelin, 1911); *Orobothriurus paessleri* (Kraepelin, 1911); *Orobothriurus peruvianus* (Mello-Leitão, 1948); *Orobothriurus dumayi* (Cekalovic, 1974); *Orobothriurus crassimanus* Maury, 1976; *Orobothriurus inca* Maury, 1976, and *Orobothriurus parvus* Maury, 1976. Five of these were originally placed in *Bothriurus* Peters, 1861. The following species were added subsequently: *Orobothriurus wawita* Acosta and Ochoa, 2000; *Orobothriurus famatina* Acosta, 2001; *Orobothriurus iskay* Acosta and Ochoa, 2001; *Orobothriurus atiquipa* Ochoa and Acosta, 2002, *Orobothriurus ampay* Ochoa and Acosta, 2003; *Orobothriurus lourencoi* Ojanguren Affilastro, 2003; *Orobothriurus grismadoi* Ojanguren Affilastro et al., 2009. *Orobothriurus dumayi* was returned to *Bothriurus* (Acosta and Ochoa, 2001; Mattoni and Acosta, 2006). Two species groups, *alticola* and *inca*, were also recognized in the genus (Maury, 1976; Acosta and Ochoa, 2001), but the monophyly of *Orobothriurus* remained doubtful (Prendini, 2000). Based on a cladistic analysis, Ochoa (2004a) described a new genus, *Pachakutej* Ochoa, 2004, to accommodate the four species of the *inca* group: *Pachakutej crassimanus* (Maury, 1976); *Pachakutej inca* (Maury, 1976); *Pachakutej iskay* (Acosta and Ochoa, 2001); *Pachakutej peruvianus* (Mello-Leitão, 1948). In the most recent taxonomic developments on this genus, Acosta (2002) transferred the enigmatic taxon, *Cercophonius brachycentrus* var. β *bivittatus* Thorell, 1877, to *Orobothriurus*, and subsequently (Acosta, 2005) recognized it as a valid species. *Orobothriurus bivittatus* (Thorell, 1877) was later synonymized with *O. alticola* (Ojanguren Affilastro et al., 2009).

In the present contribution we describe six new species of *Orobothriurus* from Argentina, Chile and Peru, collected during recent field expeditions, raising to fifteen the number of species in the genus (table 1; appendix 1), and present new records and comprehensive distribution maps for the other 10 species, along with a key to the identification of all species in the genus.

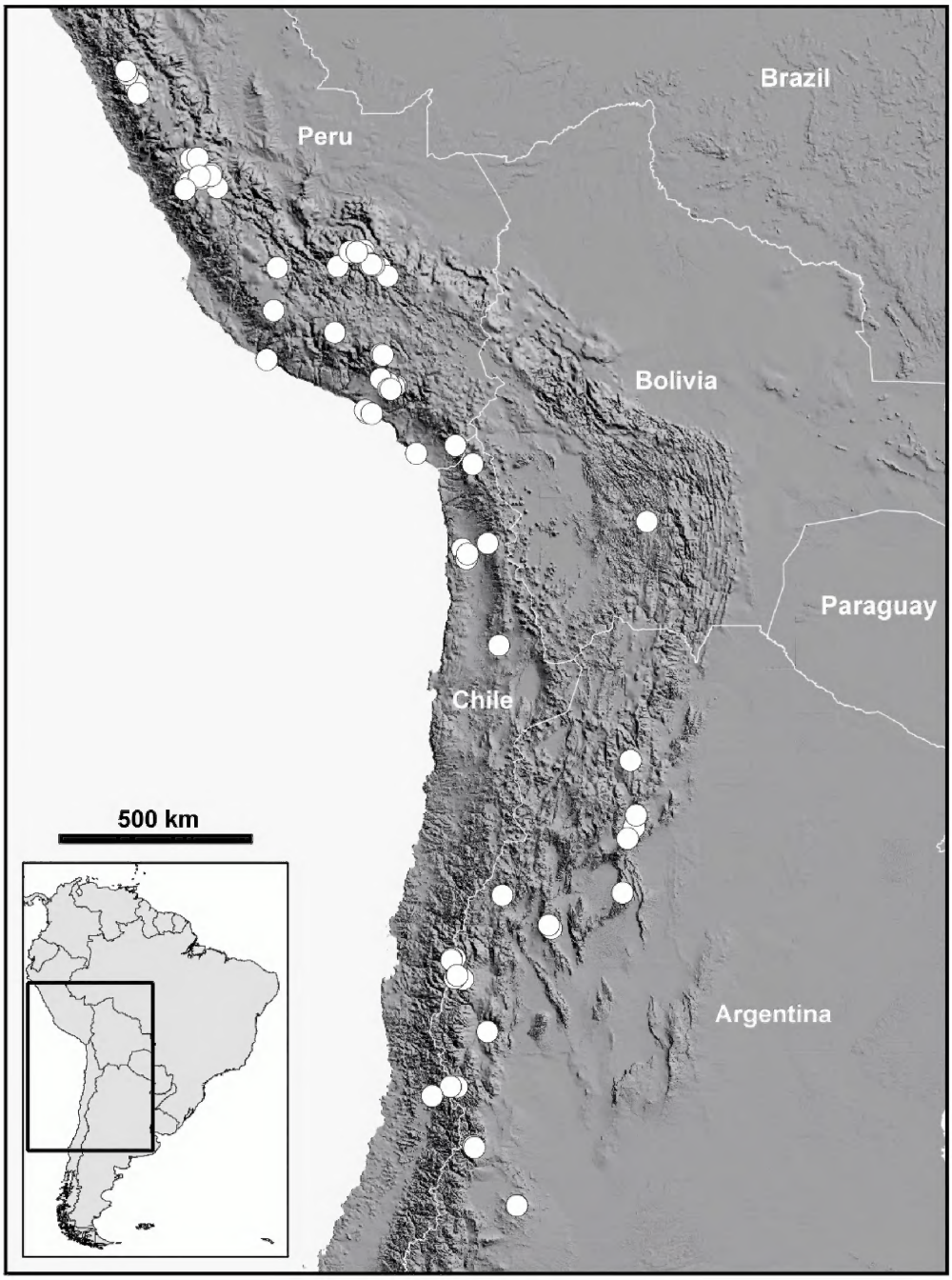

Fig. 1. *Orobothriurus* Maury, 1976, map of the distribution of the genus plotting known locality records.

MATERIAL AND METHODS

Scorpion specimens were collected by turning stones during the day, or by ultraviolet (UV) light detection at night (Stahnke, 1972). Portable UV lamps, comprising mercury vapor tubes attached to a chromium reflector, and powered by a 12V, 7 amp/hour battery, or Maglite® flashlights modified with UV LED attachments, were used in fieldwork.

Material is deposited in the following collections: American Museum of Natural History, New York (AMNH); Natural History Museum, London, U.K. (BMNH); Cátedra de Diversidad Animal I, Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Argentina (CDA); František Kovařík Private Collection, Prague, Czech Republic (FKPC); Field Museum of Natural History, Chicago. (FMNH); Instituto Argentino de Investigaciones de las Zonas Áridas, Mendoza, Argentina (IADIZA); Instituto Miguel Lillo, Tucumán, Argentina (IML); Luís Eduardo Acosta Private Collection, Córdoba, Argentina (LEA); Laboratorio de Biología Reproductiva y Evolución, Universidad Nacional de Córdoba, Argentina (LBRE); Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina (MACN-Ar); Museo de Historia Natural, Universidad Nacional de San Antonio Abad del Cusco, Peru (MHNC); Muséum d'Histoire Naturelle de Genève, Switzerland (MHNG); Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru (MUSM); Museo Regionale di Scienze Naturali, Turin, Italy (MRSN); Museu de Zoologia, Universidade de São Paulo, Brazil (MZSP); Museo de Zoología de la Universidad de Concepción, Chile (MZUC); Naturhistoriska Riksmuseet, Stockholm, Sweden (NRS); Zoologisches Museum, Universität Hamburg, Germany (ZMH).

Measurements (mm) were recorded with an ocular micrometer, and illustrations of external morphology produced using a Nikon SMZ 1500 stereomicroscope with a camera lucida. Ultraviolet fluorescence images were produced using a Microptics ML-1000 digital imaging system, or a Nikon® DS-Fi1-U2 digital camera, attached to a Nikon® SMZ 1500 steremicrocope, under long-wave UV light. Habitus images were taken using the Microptics ML-1000 system, or a Nikon® D100 digital camera, under visible light. Hemispermatophores where dissected in ethanol and manually extracted from the tissues of the paraxial organs. Illustrations of hemispermatophores were produced with a camera lucida fitted to a Leica M 165C stereomicroscope. Photographs of hemispermatophores were taken with a Leica DFC 290 camera fitted to a Leica M 165C stereomicroscope.

Morphological terminology follows Vachon (1974) for trichobothrial nomenclature; Vachon (1952) and Prendini (2000) for pedipalp carinae, abbreviated as follows: internomedian (IM), dorsointernal (DI), dorsomedian (DM), dorsoexternal (DE), externomedian (EM), ventroexternal (VE), ventromedian (VM), ventrointernal (VI), dorsal patellar process (DPP), ventral patellar process (VPP), digital (D), dorsal secondary (DS), dorsomarginal (DMA), external (E); Mattoni and Acosta (2005) for macrosetae of the metasomal segments; Stahnke (1970) for other characters; a modified version of Prendini (2004) used by Ochoa et al. (2010) for carinae of the tergites, sternites, and metasoma, abbreviated as follows: dorsolateral (DL), lateral supramedian (LSM), lateral median (LM), lateral inframedian (LIM), ventrolateral (VL), ventrosubmedian (VSM), ventromedian (VM). Hemispermatophore terminology follows Ochoa (2004a) and Mattoni and Acosta (2005).

Point-locality records were georeferenced in the field with a portable GPS (Garmin® Etrex, Garmin® Vista or Garmin® II), or retroactively using the GeoNet Names Server (GNS, http://earth-info.nga.mil/gns/html/).

Distribution maps were generated using ArcMap 9.0 (Enviromental Systems Research Institute [ESRI], Redlands, California), by superimposing point locality records of species on coverages depicting political boundaries and topography. The topographic coverage (as a shaded relief) was generated from digital elevation model files (1 arc degree resolution) from the United States Geological Survey (USGS) (http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html).

Fig. 2. *Orobothriurus* Maury, 1976, habitats in Peru. **A.** Polobaya, Arequipa (Arequipa Department), habitat of *Orobothriurus curvidigitus* (Kraepelin, 1911). **B.** Pacchac, Urubamba (Cusco Department), habitat of *Orobothriurus wawita* Acosta and Ochoa, 2000. **C.** Quiquijana, inter-Andean valley near Cusco (Cusco Department), habitat of *O. wawita*. **D.** Lomas Atiquipa (Arequipa Department), habitat of *Orobothriurus atiquipa* Ochoa and Acosta, 2002. **E.** Puna, central Peru (Junin Department), habitat of *Orobothriurus parvus* Maury, 1976.

Fig. 3. *Orobothriurus* Maury, 1976, habitats in Argentina, Chile and Peru. **A.** Pampa de Tamarugal (Tarapacá Region, Chile), habitat of *Orobothriurus tamarugal*, n. sp. **B.** Puente del Inca (Mendoza Province, Argentina), habitat of *Orobothriurus alticola* (Pocock, 1899). **C.** El Tontal (Mendoza Province, Argentina), habitat of *O. alticola*. **D.** Cerro Nevado (Mendoza Province, Argentina), habitat of *Orobothriurus grismadoi* Ojanguren-Affilastro et al., 2009. **E.** Ampay, Abancay (Apurimac Department, Peru), habitat of *Orobothriurus ampay* Ochoa and Acosta, 2003. **F.** Llanganuco (Ancash Department, Peru), habitat of *Orobothriurus huascaran*, n. sp. **G.** Sierra de Famatina (La Rioja Province, Argentina), habitat of *Orobothriurus famatina* Acosta, 2001.

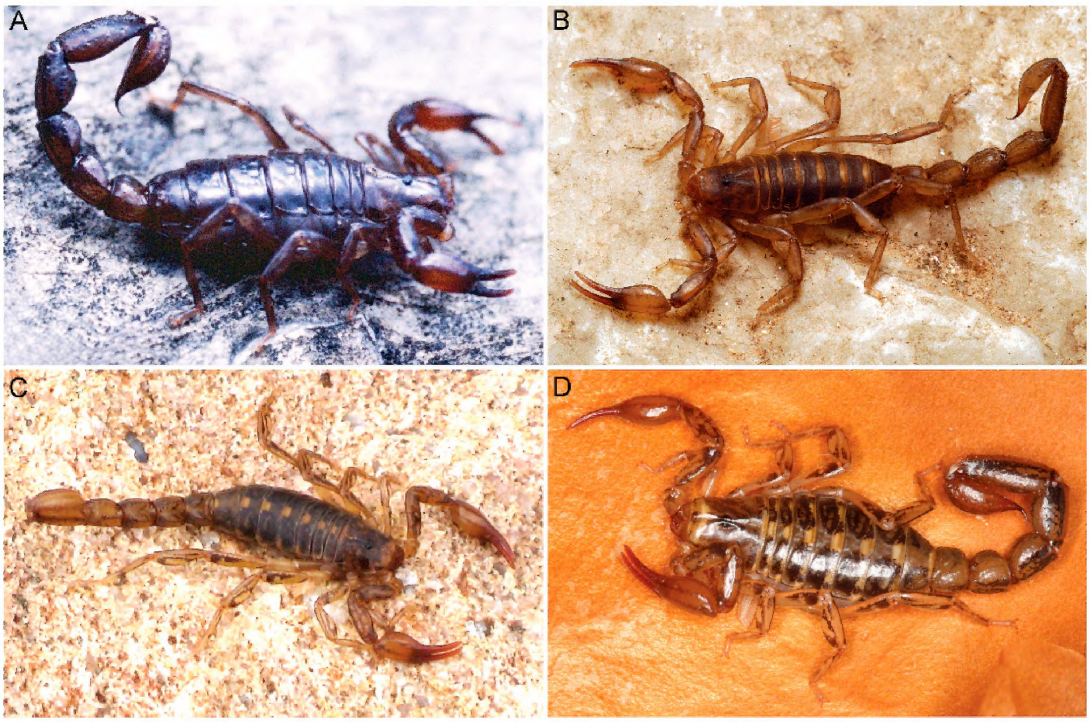

Fig. 4. *Orobothriurus* Maury, 1976, habitus in life. **A.** *Orobothriurus ampay* Ochoa and Acosta, 2003, ♀. **B.** *Orobothriurus grismadoi* Ojanguren-Affilastro et al., 2009, ♂. **C.** *Orobothriurus parvus* Maury, 1976, ♀. **D.** *Orobothriurus huascaran*, n. sp., ♀.

ON THE DISTRIBUTION OF *OROBOTHRIURUS*

Most species of *Orobothriurus* inhabit the Andes and orographic systems of Argentina, Bolivia, Chile and Peru, where they have been collected up to 4910 m. However, some species occur at low altitude near the Pacific coast (figs. 1, 53). All *Orobothriurus* species are allopatric (figs. 52–54). This pattern of

TABLE 1

Currently recognised species of the scorpion genus *Orobothriurus* Maury, 1976, with countries and provinces (Argentina), regions (Chile) or departments (Peru) from which they have been recorded. *Orobothriurus lourencoi* Ojanguren Affilastro, 2003, is excluded as this species will be placed in another genus (Mattoni et al., in litt.)

Orobothriurus alticola (Pocock, 1899)	Argentina: Mendoza, San Juan
Orobothriurus ampay Ochoa and Acosta, 2003	Peru: Apurímac
Orobothriurus atiquipa Ochoa and Acosta, 2002	Peru: Arequipa
Orobothriurus calchaqui, n. sp.	Argentina: Tucumán
Orobothriurus compagnuccii, n. sp.	Argentina: La Rioja
Orobothriurus curvidigitus (Kraepelin, 1911)	Peru: Arequipa
Orobothriurus famatina Acosta, 2001	Argentina: La Rioja
Orobothriurus grismadoi Ojanguren Affilastro et al., 2009	Argentina: Mendoza
Orobothriurus huascaran, n. sp.	Peru: Ancash
Orobothriurus paessleri (Kraepelin, 1911)	Peru: Arequipa
Orobothriurus parvus Maury, 1976	Peru: Junin, Lima
Orobothriurus quewerukana, n. sp.	Chile: Tarapacá, Peru: Tacna
Orobothriurus ramirezi, n. sp.	Chile: Coquimbo
Orobothriurus tamarugal, n. sp.	Chile: Tarapacá
Orobothriurus wawita Acosta and Ochoa, 2000	Peru: Ayacucho, Cusco

distribution is probably related to the origin and subsequent development of the Andes, which promoted geographical isolation of *Orobothriurus* populations and speciation by vicariance (Ochoa, 2005).

Orobothriurus and another bothriurid genus, *Brachistosternus* Pocock, 1893, are the most diverse scorpion genera in the high Andes (Ojanguren Affilastro, 2003b; Ochoa, 2005). There are several records of *Orobothriurus* species occurring in sympatry with *Brachistosternus* species, e.g.: *O. alticola* with *Brachistosternus montanus* Roig Alsina, 1977; *O. quewerukana* with *Brachistosternus quiscapata* Ochoa and Acosta, 2002; *O. ramirezi* with *Brachistosternus perettii* Ojanguren Affilastro and Mattoni, 2006; *O. tamarugal* with *Brachistosternus donosoi* Cekalovic, 1974; *O. wawita* with *Brachistosternus andinus* Chamberlin, 1916. However, there are also vast areas in the Altiplano of southern Peru, western Bolivia, and northwestern Argentina where *Orobothriurus* have not been recorded, although the vegetation, altitude, and climate of these areas appear suitable (fig. 1). Thus far, only *Brachistosternus* have been recorded there.

Although the distribution of *Orobothriurus* generally follows the Andes, these scorpions occur in a variety of different habitats, at altitudes ranging from sea level, close to the Pacific coast, to the high Andes. Two species, *O. atiquipa* and *O. paeslleri*, inhabit Lomas biotopes below 1000 m in southern Peru (figs. 2D, 53; Ochoa, 2005). *Orobothriurus tamarugal* inhabits an isolated forest of *Prosopis tamarugo* Phil. (Fabaceae) in northern Chile (figs. 3A, 53). The remaining species occur in different Andean habitats above 2500 m, including semi-arid zones with scrub and thorny steppe on the western slopes of the Andes in Chile and Peru: *O. curvidigitus* and *O. quewerukana* (figs. 2A, 53); forest and/or shrub vegetation in the inter-Andean valleys of Peru: *O. ampay* and *O. wawita* (figs. 2B, C, 3E, 52); and high-altitude montane environments with typical Prepuna, Puna and Altoandina vegetation: *O. alticola*, *O. calchaqui*, *O. compagnuccii*, *O. famatina*, *O. grismadoi*, *O. huascaran*, *O. parvus*, and *O ramirezi* (figs. 2E, 3B–D, F, G, 52, 54).

Most *Orobothriurus* species occur at high altitudes, e.g., *O. alticola* occurs up to 4000 m in central Argentina (fig. 3B, C), *O. parvus* up to 4700 m in central Peru (fig. 2E), and *O. huascaran* up to 4910 m in central Peru, the world's altitude record for a scorpion (fig. 3F). Drastic climatic conditions are experienced at these altitudes.

Species diversity reduces with increasing altitude in high mountains in many taxa (Lomolino, 2001). Few scorpion species are found in high mountain habitats (Polis, 1990; Lourenço and Qi, 2006). In South America, only 39 scorpion species have been recorded from above 3000 m in the Andes, from Argentina, Bolivia, Chile, Colombia, Ecuador and Peru (table 2). Thirty belong to the family Bothriuridae Simon, 1880, the remaining nine to Buthidae C.L. Koch, 1837, Chactidae Pocock, 1893, and Iuridae Thorell, 1876, and are mostly restricted to central and northern South America, where the climatic conditions at higher altitude are more favorable. Two bothriurid genera dominate these montane biotopes: *Orobothriurus* (12 species, 80% of the species in the genus) and *Pachakutej* (four species, 66%) (Maury, 1976; Ochoa 2004a, 2005; Ojanguren Affilastro et al., 2009). Another bothriurid genus, *Brachistosternus*, contains 12 species in the high Andes, but this number represents only 29% of the species in the genus (Roig Alsina, 1977; Maury, 1978, 1979; Ochoa and Acosta, 2002b; Ojanguren Affilastro, 2002, 2003b, 2004; Ochoa, 2004b, 2005; Ojanguren Affilastro and Mattoni, 2006; Ojanguren Affilastro et al., 2007b; Ojanguren Affilastro and Ramirez, 2009). Four other genera are represented by only a few species at these high altitudes: *Hadruroides* Pocock, 1893 (two species, 12% of the species in the genus), *Teuthraustes* Simon, 1878 (two species, 10%), *Bothriurus* Peters, 1861 (two species, 4%), and *Tityus* C.L. Koch, 1836 (five species, less than 2%) (Maury, 1979; Francke and Soleglad, 1980; Lourenço and Maury, 1985; Lourenço, 1995; Acosta, 1997; Acosta and Ochoa, 2001; Flórez, 2001; Acosta, 2005; Lourenço, 2005; Ochoa, 2005; Ojanguren Affilastro, 2005; Ochoa and Chaparro, 2008; Ochoa and Prendini, 2010).

TABLE 2
Scorpion species recorded above 3000 m in the Andes

References: 1: Acosta, 1997; 2: Acosta, 2005; 3: Acosta and Ochoa, 2000; 4: Acosta and Ochoa, 2001; 5: Acosta and Ochoa, 2002; 6: Flórez, 2001; 7: Francke and Soleglad, 1980; 8: Maury, 1976; 9: Maury, 1978; 10: Maury, 1979; 11: Maury, 1984; 12: Lourenço, 1995; 13: Lourenço, 2005; 14: Lourenço and Maury, 1985; 15: Ochoa, 2004a; 16: Ochoa, 2004b; 17: Ochoa, 2005; 18: Ochoa and Acosta, 2002b; 19: Ochoa and Acosta, 2003; 20: Ochoa and Chaparro, 2008; 21: Ojanguren Affilastro, 2002; 22: Ojanguren Affilastro, 2003b; 23: Ojanguren Affilastro, 2004; 24: Ojanguren Affilastro, 2005; 25: Ojanguren Affilastro and Mattoni, 2006; 26: Ojanguren Affilastro et al., 2007; 27: Ojanguren Affilastro et al., 2007; 28: Ojanguren Affilastro et al., 2009; 29: Roig Alsina, 1977; 30: This article; 31: Unpublished data.

Family	Species	Altitude	Country	Reference
Bothriuridae	*Orobothriurus huascaran*, n. sp.	3730–4910 m	Peru	30
Bothriuridae	*Orobothriurus parvus* Maury, 1976	3400–4750 m	Peru	8, 30
Bothriuridae	*Brachistosternus montanus* Roig Alsina, 1977	2700–4540 m	Argentina	24, 29, 31
Bothriuridae	*Brachistosternus galianoae* Ojanguren Affilastro, 2002	4300–4500 m	Bolivia	21, 31
Bothriuridae	*Brachistosternus piacentinii* Ojanguren Affilastro, 2003	4300–4500 m	Bolivia, Chile	22, 27
Bothriuridae	*Bothriurus bocki* Kraepelin, 1911	2440–4360 m	Bolivia	5, 11
Bothriuridae	*Orobothriurus calchaqui*, n. sp.	2700–4300 m	Argentina	30
Bothriuridae	*Brachistosternus intermedius* Lönnberg, 1902	2500–4252 m	Argentina, Bolivia	23, 24, 31
Buthidae	*Tityus argentinus scaber* (Werner, 1939)	4200 m	Bolivia	6
Buthidae	*Tityus chilensis* Lourenço, 2006	4080 m	Chile	13
Bothriuridae	*Brachistosternus ninapo* Ochoa, 2004	2900–4050 m	Peru	16, 17
Bothriuridae	*Orobothriurus ramirezi*, n. sp.	3300–4030 m	Chile	30
Bothriuridae	*Orobothriurus alticola* (Pocock, 1899)	2700–4005 m	Argentina	2, 8, 10, 24, 28, 30
Bothriuridae	*Bothriurus olaen* Acosta, 1997	600–4000 m	Argentina	1, 31
Bothriuridae	*Brachistosternus titicaca* Ochoa and Acosta, 2002	3850–3900 m	Bolivia, Peru	17, 18
Bothriuridae	*Orobothriurus compagnuccii*, n. sp.	3200–3900 m	Argentina	30
Bothriuridae	*Orobothriurus wawita* Acosta and Ochoa, 2000	2700–3800 m	Peru	3, 17, 30
Bothriuridae	*Orobothriurus quewerukana*, n. sp.	2822–3732 m	Chile, Peru	30
Bothriuridae	*Brachistosternus kovariki* Ojanguren Affilastro, 2003	3200–3600 m	Chile	22, 27
Bothriuridae	*Brachistosternus perettii* Ojanguren Affilastro and Mattoni, 2006	3200–3600 m	Chile	25, 27
Bothriuridae	*Orobothriurus curvidigitus* (Kraepelin, 1911)	2300–3600 m	Peru	8, 17, 30
Bothriuridae	*Orobothriurus ampay* Ochoa and Acosta, 2003	3100–3550 m	Peru	17, 19
Bothriuridae	*Brachistosternus quiscapata* Ochoa and Acosta, 2002	3000–3400 m	Chile, Peru	17, 18
Iuridae	*Hadruroides bustamantei* Ochoa and Chaparro, 2008	2600–3379 m	Peru	20, 31
Bothriuridae	*Brachistosternus andinus* Chamberlin, 1916	2780–3350 m	Peru	9, 17
Bothriuridae	*Pachakutej oscari* Ochoa, 2004	3250–3300 m	Peru	15, 17
Chactidae	*Teuthraustes atramentarius* Simon, 1878	2500–3300 m	Ecuador	12, 31
Buthidae	*Tityus footei* Chamberlin, 1916	800–3300 m	Peru	14, 17
Bothriuridae	*Brachistosternus prendinii* Ojanguren Affilastro, 2003	2800–3200 m	Chile	22, 27
Bothriuridae	*Orobothriurus famatina* Acosta, 2001	2500–3200 m	Argentina	4, 24, 30
Chactidae	*Teuthraustes oculatus* Pocock, 1900	2920–3150 m	Ecuador	12, 31

TABLE 2
(Continued)

Family	Species	Altitude	Country	Reference
Bothriuridae	*Orobothriurus grismadoi* Ojanguren Affilastro et al., 2009	2900–3130 m	Argentina	28
Iuridae	*Hadruroides mauryi* Francke and Soleglad, 1980	2750–3100 m	Peru	7, 17
Bothriuridae	*Pachakutej peruvianus* (Mello-Leitão, 1948)	2600–3100 m	Peru	8, 31
Buthidae	*Tityus columbianus* (Thorell, 1876)	2200–3100 m	Colombia	6
Bothriuridae	*Pachakutej inca* (Maury, 1976)	3000 m	Peru	8
Bothriuridae	*Brachistosternus coquimbo* Ojanguren Affilastro et al., 2007	2850–3000 m	Chile	26
Bothriuridae	*Pachakutej iskay* (Acosta and Ochoa, 2001)	2800–3000 m	Peru	4, 17
Buthidae	*Tityus soratensis* Kraepelin, 1911	2800–3000 m	Bolivia, Peru	5, 14, 17

ON THE ALTITUDE RECORD FOR SCORPIONES

Polis (1990: 252) reported the highest known altitude record for a scorpion as 5550 m for *Pachakutej crassimanus* (Maury, 1976) (as *Orobothriurus crassimanus*) in the Peruvian Andes, based on a personal communication by W.R. Lourenço. Lourenço (1997: 598) amended the data to 5560 m, providing more details about the localities and collection data, recorded in 1981 at Nevado Huascarán (Peru). Subsequent authors cited this as the altitude record for a scorpion species (Coddington and Colwell, 2001; Lourenço, 2002, 2003; Lourenço and Qi, 2006; Prendini, 2006). Unfortunately, this record is both erroneous and based on a misidentification.

We reviewed the material studied by W.R. Lourenço, deposited in MHNG. This material is labelled from the following localities: "Llanganuco, Nevado de Huascarán" (3 ♀, 4300 m; 2 ♀, 4400–5500 m; 1 ♂, 5560 m); "Laguna Parón" (1 ♀, 4000 m); "Quebrada Querococha-Catac" (1 ♂, 2 ♀, 3900 m); and "Recuay, Huama" (2 ♂, 4 ♀, 14 juv., 4200 m). We could not locate the fourth locality record (Huama), which probably corresponds to Huaraz (see Material Examined for *O. huascaran*). All except one of these specimens are conspecific with *O. huascaran*, not *P. crassimanus*. *Pachakutej crassimanus* is known only from the type locality at 2850 m, in the Cajamarca Department of northern Peru, 230 km from Huascarán (Maury, 1976; Ochoa, 2004a), and does not occur at Llanganuco.

The exception is an adult male specimen labelled "Llanganuco, Nevado Huascarán, 5560 m," which is not *P. crassimanus* but a species of *Hadruroides* Pocock, 1893 (Iuridae), as illustrated by Lourenço's (1997: 589) figures 1 and 2. The locality data for this misidentified specimen, allegedly collected at 5560 m, are obviously erroneous. No *Hadruroides* species have been recorded above 4000 m (Maury, 1975; Ochoa and Prendini, 2010), although *Hadruroides* are present in Yungay, at the bottom of the valley between 2500 m and 3000 m, just 12 km SW of Laguna Llanganuco. Nevado Huascarán, the highest mountain in Peru (6768 m), gives its name to the surrounding Huascarán National Park. The mountain trail to Nevado Huascarán starts in Yungay and continues through the Llanganuco ravine. The misidentified *Hadruroides* specimen was therefore probably collected near Yungay.

The altitude data for the remaining MNHG specimens of *O. huascaran* from Llanganuco, collected at 4000 m, 4300 m, 4400 m, and 5500 m, are also imprecise. Laguna Llanganuco or Chinancocha is situated at 3835 m and we assume that the specimens were collected on the ascent to Nevado Huascarán (Llanganuco ravine), probably in the vicinity of the base camp (4100 m). It is unlikely that scorpions survive above 5200 m, or even lower in certain areas, as the ground is permanently covered by snow and ice (glacier). When the area was visited in 1998, suitable habitats for scorpions and other arthropods

existed up to about 5100 m. Due to the effects of global warming and the retreat of glaciers, this altitude may have increased during the past decade. However, when the MHNG specimens were collected in 1981, the snow line was considerably lower (Byers, 2000).

In light of the above deductions, we correct the altitude record for scorpions. Based on available data, the world's altitude record for a scorpion is 4910 m for *O. huascaran*, collected in the Ishinca ravine (09°22′28″S 77°24′36″W), Huaraz Province, central Peru, not 5550 m for *Pachakutej crassimanus* (Maury, 1976) as published (Polis, 1990; Lourenço, 1997, 2002, 2003; Coddington and Colwell, 2001; Lourenço and Qi, 2006; Prendini, 2006).

SYSTEMATICS

FAMILY BOTHRIURIDAE SIMON, 1880
OROBOTHRIURUS Maury, 1976

Bothriurus "group C - *Bothriurus coriaceus*" Mello-Leitão, 1934: 62 (part).

Bothriurus (*Andibothriurus*) Bücherl et al., 1963: 209 (part) [nomen nudum, *nec Bothriurus* (*Andibothriurus*) Maury, 1976: 15].

Orobothriurus Maury, 1976: 14–17 (part), type species by original designation: *Bothriurus alticola* Pocock, 1899 [= *Orobothriurus alticola* (Pocock, 1899)]; Francke, 1977: 75 (part); Maury, 1979: 709; Francke, 1985: 11, 15 (part); Sissom, 1990: 87, 88 (part); Lourenço, 1997: 588 (part); Acosta and Maury, 1998: 550, 554, 559; Lowe and Fet, 2000: 35–37 (part); Acosta and Ochoa, 2000: 137 (part); 2001: 203, 205 (part); Lourenço and Dastych, 2001: 54 (part); Ochoa and Acosta, 2002a: 98, 99; 2003: 1, 2; Soleglad and Fet, 2003: 88 (part); Ojanguren Affilastro, 2003a: 117 (part); Ochoa, 2004a: 52–55, 73, figs. 1–2, 8–9, 20A–B, 21; Acosta, 2005: 2; Fet and Soleglad, 2005: 13; Ochoa, 2005: 55, 56, 65, figs. 7, 16; Ojanguren Affilastro, 2005: 80, 82, 176, 177; Prendini and Wheeler, 2005: 481; Rein, 2007: 5; Dupré, 2007: 8, 12; Ojanguren Affilastro et al., 2009: 28.

Orobothriurus "*alticola* group": Acosta and Ochoa, 2001: 205; Ochoa and Acosta, 2002a: 99; 2003: 2; Ojanguren Affilastro, 2003a: 117.

DIAGNOSIS: The genus *Orobothriurus* comprises small, slender scorpions, varying from 18.3 mm (male *O. wawita*) to 51.5 mm (female *O. quewerukana*) in total length. *Orobothriurus* may be distinguished from other bothriurid genera by the distinctive morphology of the hemispermatophore (fig. 10), which is slender with a reduced lobe region. The frontal crest of the hemispermatophore is divided in two parts: the proximal part is oblique and the distal part straight with a lateral projection on both the ental and ectal surfaces. The basal lobe forms a tortuous stem with a typical subdistal spatulate dilation.

The genus may be further distinguished on the following diagnostic characters. The male pedipalp chela manus possesses an acuminate conical apophysis on the internal surface. Trichobothrium *ib* is situated at the base of this apophysis. The VSM carinae of metasomal segment V are arranged in parallel and situated close to the VL carinae. The female genital opercula are more elongated posteriorly, with more rounded anterior edges, than those of other bothriurid genera.

REMARKS: The characters shared by most *Orobothriurus* species are as follows. The coloration is usually yellowish. The pigmentation pattern of the mesosoma typically comprises two sublateral spots on each tergite, leaving an unpigmented median stripe along the length of the mesosoma (fig. 13C, E–G), except in *O. ampay*, in which tergites I–VII are completely pigmented (fig. 12D), and *O. grismadoi*, in which tergite VII is almost completely pigmented (fig. 13G).

The metasomal segments usually exhibit a single VM and paired VL stripes (figs. 11B, C, 13A). The VM stripe is contiguous with the paired VL stripes in the posterior third of the segment (fig. 11A) in *O. ampay*, and absent in *O. wawita* (fig. 13D). The carapace anterior margin is almost straight, either with a weak median projection (epistome) or a shallow median notch. The anteromedian longitudinal sulcus is complete but weakly developed, the posteromedian longitudinal sulcus well developed, the median ocular tubercle low, and situated anteromedially on the carapace (figs. 14–16). The metasomal segments are elongated, with variable carinal development (figs. 17–22). The DL carinae occupy the entire length of segments I–IV, and usually comprise granules of medium size. The ML, LIM, and VL carinae are variable, usually present on segments I and II. The LSM carinae are absent or obsolete.

The VSM carinae are present on segments I and II in most species (figs. 17–19), extending to IV in *O. ampay* (fig. 17B). The VM carina of metasomal segment V is granular (figs. 20, 21A, B, D–F, 22), except in the male of *O. wawita*, in which it is absent (fig. 21C). The VSM carinae are arranged in parallel and situated close to the VL carinae, except in *O. atiquipa* and *O. wawita*, where they are absent (figs. 21A, C, 22F). Metasomal segment I possesses 2 or 3 pairs of VL and VSM macrosetae, II and III each possess 3 pairs, IV, 3–5 pairs, and V, 3 or 4 pairs (fig. 6). The male telson vesicle is narrower than that of the female, with a weakly developed dorsal gland that is not always apparent (fig. 23).

The sternum is transverse with 2 or 4 macrosetae. The genital operculum is divided longitudinally, comprising two subtriangular sclerites, joined by flexible tissue in the anterior half, each sclerite tapering posteriorly, the sclerites of females being more elongated posteriorly, with the anterior edges more rounded (fig. 9) than those of males.

Each pecten comprises more than 10 teeth, fulcra, and a single row of median lamellae, the first being dilated (fig. 9). The cheliceral manus possesses 2 or 3 macrosetae near the movable finger articulations. The movable finger possesses two subdistal teeth and is more strongly curved in the male than the female. The ventrointernal margin of the fixed finger and ventral surface of the movable finger are setose basally.

The basitarsi possess two well-developed, symmetric pedal spurs. The telotarsi are elongated, with a ventromedian row of elongated spinules, and well-developed pro- and retroventral rows of spiniform macrosetae with the following formula on legs I–IV: 1/1, 2/2, 3/3, 3/3, except in *O. atiquipa*, which has 3/4 spiniform macrosetae in the pro- and retroventral on legs III and IV. The telotarsal ungues are curved and symmetric.

The pedipalps are usually elongated, especially in adult males, with a slender, prismatic chela in most species. The male chela manus of all species, except *O. ampay* and *O. wawita*, possesses an acuminate conical apophysis on the internal surface (fig. 8B). The pedipalp chelal carinae are usually absent or obsolete, evident only by differences in the angles between surfaces, but at least the D, DS, DMA, DI, and VM carinae may be identified, depending on the species, with vestigial VI and IM carinae also evident in several species (Ochoa, 2004a). The median denticle row of the chela fingers comprises 4–6 pairs of internal and external accessory denticles.

The pedipalp trichobothriotaxy is neobothriotaxic major Type C (Vachon, 1974; figs. 7, 8). The femur possesses three trichobothria (*d*, *i*, *e*). The patella possesses 19 trichobothria, one of which is petite (esb_2): one internal (*i*), two dorsal ($d_{1,\ 2}$), three ventral ($v_{1–3}$), and 13 external ($et_{1–3}$, *est*, $em_{1,\ 2}$, $esb_{1,\ 2}$, $eb_{1–5}$). The chela possesses 27 trichobothria, including one accessory trichobothrium in the *V* series, and two petite trichobothria (Et_4, *Esb*): 18 trichobothria are situated on the chela manus ($Et_{1–5}$, *Est*, *Esb*, $Eb_{1–3}$, $V_{1–5}$, *Dt*, *Db*, *db*) and nine on the fixed finger (*et*, *est*, *esb*, *eb*, *dt*, *dst*, *dsb*, *it*, *ib*). Macroseta M_1 is situated near trichobothrium *e* on the pedipalp femur (fig. 7A). On the pedipalp chela, trichobothrium *db* is situated medially; Et_3 is situated either in the same same axis as, or proximal to *Est*; *Esb* is situated either between Eb_2 and Eb_3 or dorsal to Eb_2; V_1, V_2, and V_3 are situated in the same axis; *dst* is situated proximal to *est*; *Db* is equidistant between *Dt* and Eb_3 (except in *O. huascaran*); Et_5 forms an obtuse angle with *eb* and Et_4 (fig. 8A); and *ib* is situated at the base of the apophysis on the internal surface of the chela manus of adult males, where it is not visible in ventral view (fig. 8C).

The hemispermatophore is lamelliform and slender (fig. 10). The elongated distal lamina is separated into two parts, a basal portion delimited by the frontal crest, and a distal portion termed the apex (Ochoa, 2004a). The apex comprises two parts, a narrow base termed the pedicel, and a subtriangular distal part that includes the distal crest. The frontal crest is further divided into two parts: the proximal part is oblique and possesses two lateral folds, the distal part is straight and usually parallel to the ventral margin of the lamina, with a lateral projection on both the ental and ectal surfaces. The distal edge exhibits a small incision and, in most species, there is a constriction along the border at the point of inflexion. The shape and length of the apex and frontal crest vary among the species (figs. 27, 28, 32, 36, 40, and 47). The lobe

region is greatly reduced, the capsular concavity is shorter than the fold of the internal lobe, and the basal lobe forms a tortuous stem with a subdistal spatulate dilation ending in a terminal process (fig. 10).

INCLUDED TAXA: Fifteen species (table 1). *Orobothriurus lourencoi* Ojanguren Affilastro, 2003, will be placed in another genus based on phylogenetic analysis (fig. 5, appendix 2; Mattoni et al., in litt.).

DISTRIBUTION: *Orobothriurus* is endemic to Argentina, Bolivia, Chile and Peru (table 1). Five of the described species are endemic to Argentina, two to Chile and seven to Peru.

KEY TO IDENTIFICATION OF THE SPECIES OF *OROBOTHRIURUS*

1. Tergites I–VI entirely and densely pigmented (fig. 12D); metasomal segments I–V, VM stripe contiguous with paired VL stripes posteriorly (fig. 11A); metasomal segment IV, VSM carinae present (fig. 16B); angle formed between pedipalp chela trichobothria *eb*–Et_5–Et_4 less than 90° (fig. 25A). . . . . *O. ampay*
– Tergites I–VI each with paired lateral spots of pigmentation delimiting unpigmented median longitudinal stripe (fig. 13C, E–G); metasomal segments I–V, VM stripe not contiguous with paired VL stripes posteriorly (at least on segments IV and V; figs. 11B–D, 13A, D); metasomal segment IV, VSM carinae absent (fig. 17A); angle formed between pedipalp chela trichobothria *eb*–Et_5–Et_4 greater than 90° (fig. 25B, D) 2
2. Carapace, anterior margin with weak median projection (epistome) (fig. 14C, 15A, C, D); pedipalp chela, movable finger (♂) distinctly curved (fig. 26B, C). 3
– Carapace, anterior margin sublinear or emarginate, with shallow median notch (figs. 14A, B, D, 15B, 16); pedipalp chela, movable finger (♂) straight (figs. 25B, D, 31C). . . 6
3. Metasomal segment V (♀) slightly elongated, length greater than or equal to twice its width (fig. 22C); metasomal segment I with two pairs of VSM macrosetae (fig. 19A, C, F); pedipalp chela, movable finger (♂) strongly curved (figs. 26C, 43C, 51A) 4
– Metasomal segment V (♀), length less than twice its width (fig. 22B); metasomal segment I with three pairs of VSM macrosetae (fig. 19B); pedipalp chela, movable finger (♂) slightly curved (fig. 26B) . . . *O. paessleri*
4. Carapace, tergites, metasomal segments, ventral surface unpigmented (fig. 49); sternite VII finely granular (fig. 19F); metasomal segments I–IV, VSM carinae present, at least on segments I and II (fig. 19F); hemispermatophore, frontal crest shorter than apex length, ventral border of distal part of apex straight (fig. 47C, D) . . . . . ***O. tamarugal***
– Carapace, tergites, metasomal segments, ventral surface pigmented (figs. 11B, 13E); sternite VII smooth or nearly so (fig. 19A, C); metasomal segments I–IV, VSM carinae absent (fig. 19A, C); hemispermatophore, frontal crest slightly elongated, length greater than or equal to apex length, ventral border of distal part of apex slightly curved (figs. 28B, D, 38D, E) 5
5. Carapace, tergites, metasomal segments, and pedipalps markedly pigmented (figs. 11B, 12C, 13E); telson vesicle, ventral surface (♂) granular in anterior third; pedipalp chela, trichobothrium *Esb* situated between trichobothria Eb_2 and Eb_3; hemispermatophore, distal crest without folds (fig. 28B) . . . . . ***O. curvidigitus***
– Carapace and tergites faintly pigmented, metasomal segments and pedipalps unpigmented (fig. 41); telson vesicle, ventral surface (♂) entirely granular (fig. 23F); pedipalp chela, trichobothrium *Esb* situated dorsal to trichobothrium Eb_2; hemispermatophore, distal crest with one or two small folds (fig. 40E) . . . . . ***O. quewerukana***
6. Hemispermatophore, frontal crest reduced, length less than apex length (figs. 27, 36F–H, K–O) 7
– Hemispermatophore, frontal crest elongated, length greater than apex length (fig. 36D, E, I, J) 11
7. Metasomal segments I–III, dorsal surfaces each with two median subtriangular spots (occasionally absent on I), usually separated medially by narrow unpigmented line (fig. 12A, C); segment IV with three pairs of VSM macrosetae. 8
– Metasomal segments I–III, dorsal surfaces each without median spots, but with reticulate pigmentation along DL carinae (fig. 12B, 13C); segment IV with four or five pairs of VSM macrosetae (fig. 17A) 10
8. Carapace, anterior margin with shallow median notch (fig. 14B); metasoma (♂), VL and VSM carinae obsolete, granular on segment I, absent on II (fig. 18F); hemispermatophore apex 52%–54% of lamina length, terminal process of basal lobe well developed (figs. 32C, D, 36A–C) . . . . ***O. compagnuccii***
– Carapace, anterior margin with deep median notch (fig. 14A); metasoma (♂), VL and

VSM carinae well developed, granular, occupying entire length of segment I and weakly developed but complete on II; hemispermatophore apex 66%–72% of lamina length, terminal process of basal lobe small (fig. 32A, B, 36F–H, K–O) 9

9. Metasomal segment IV with two or three pairs of ML macrosetae; segment III usually with one pair of DL macrosetae . . . ***O. calchaqui***
– Metasomal segment IV with one pair of ML macrosetae; segment III usually without DL macrosetae . . . . . ***O. famatina***
10. Pedipalp chela manus (♂), internal surface with apophysis (fig. 8B); pedipalp chela fixed finger (♂) slightly curved, creating small gap with movable finger when fingers closed (fig. 22A); metasomal segment V, VL and VM carinae complete (fig. 22E); metasomal segments with distinct VM pigmentation stripe (at least on segments II–V); hemispermatophore, ventral border of apex slightly curved (fig. 27B) . . . . . ***O. parvus***
– Pedipalp chela manus (♂), internal surface without apophysis (fig. 25C); pedipalp chela fixed finger (♂) straight, no gap evident when fingers closed (fig. 25B); metasomal segment V, VL and VM carinae absent (♂; fig. 21C) or restricted to distal third (♀; fig. 22F); metasomal segments irregularly pigmented, VM pigmentation stripe indistinct (fig. 13D); hemispermatophore, ventral border of apex straight (fig. 27C) . . . . . ***O. wawita***
11. Metasoma segments I–III (♀), VSM carinae present (fig. 19D); segment V, VL and VM carinae restricted to posterior two-thirds (fig. 21F); pedipalp chela manus, trichobothrium *Esb* situated between Eb_2 and Eb_3, *Db* slightly closer to *Dt* than to Eb_3 (fig. 39C); hemispermatophore, distal border of apex slightly rounded, frontal crest with internal lateral projection vestigial (fig. 40A–C) . . . . . ***O. huascaran***
– Metasoma segments I–III (♀), VSM carinae absent; metasomal segment V, VL, and VM carinae complete (fig. 20A, C, F); pedipalp chela manus, trichobothrium *Esb* situated dorsal to Eb_2, *Db* equidistant between *Dt* and Eb_3 (figs. 25D, 46B, C); hemispermatophore, distal border of apex subtriangular, frontal crest with internal lateral projection complete (figs. 28A, 47A, B) 12
12. Sternite VII acarinate (fig. 18A); metasomal segment II (♂), VSM carinae absent (fig. 18A); segment V, VSM and VM carinae not discernible from dense surface granulation (fig. 21A); legs III and IV, telotarsi each with 3/4 spiniform macrosetae in pro- and retroventral rows; metasomal segments I–III, paired VL stripes contiguous with VM stripe posteriorly (but not on segments IV and V) (fig. 11D); segment IV with four pairs of VSM macrosetae. . . . . ***O. atiquipa***
– Sternite VII with one or two pairs of carinae (fig. 18C, D); metasomal segment II (♂), VSM carinae present; segment V, VM, and VL carinae well defined (figs. 20A, C, F, 21E); legs III and IV, telotarsi each with 3/3 spiniform macrosetae in pro- and retroventral rows; metasomal segments I–V, paired VL stripes not contiguous with VM stripe posteriorly (fig. 11C); segment IV with three pairs of VSM macrosetae 13
13. Hemispermatophore apex elongated, angle of inclination 135.18°–139.1° (fig. 36D, E); tergite VII entirely pigmented (fig. 13G); telson vesicle (♂), dorsal surface concave (fig. 23E) . . . . . ***O. grismadoi***
– Hemispermatophore apex short, angle of inclination 138.99°–144.99° (figs. 36I, J, 47A, B); tergite VII with paired lateral spots of pigmentation delimiting unpigmented median longitudinal stripe (fig. 13F); telson vesicle (♂), dorsal surface flat (fig. 23A) 14
14. Hemispermatophore, distal crest extremely developed, extending almost entire length of lamina (fig. 47A, B); telson length/width ratio (♂), 2.65–2.94 (mean = 2.78), (♀), 2.13–2.37 (mean = 2.27). . . . . ***O. ramirezi***
– Hemispermatophore, distal crest restricted to distal half of lamina (fig. 36I); telson length/width ratio (♂), 2.87–3.21 (mean = 3.07), (♀), 2.44–2.55 (mean = 2.49) . . . ***O. alticola***

Orobothriurus alticola (Pocock, 1899)

Figures 13F, 15B, 18D, 20A, 21A, 36I, J, 54

Cercophonius brachycentrus var. β *bivittatus* Thorell, 1877: 183 [synonymized by Ojanguren Affilastro et al., 2009: 35].

Bothriurus alticola Pocock 1899: 357–358, fig. 1; Kraepelin, 1911: 91, 97; Mello-Leitão, 1931: 82, 92; 1932: 34; 1934: 63, 65; 1935: 93; 1937: 103; 1945: 138, 144, 145; Bücherl, 1959a: 23, 24, fig. 4; Abalos, 1959: 591; 1963: 113; Cekalovic, 1966: 3; Bücherl, 1969: 769; Maury, 1973: 110; Roig Alsina, 1973: 198; Masnú de Moreno, 1991: 184, 189, map 1.

Bothriurus (*Andibothriurus*) *alticola*: Bücherl et al., 1963: 217, 224, fig. 8.

Urophonius brachycentrus bivittatus: Mello-Leitão 1931: 99–100; 1932: 35; 1934: 48, 51; 1938: 94–95; 1945: 213, 215; Acosta and Maury, 1998: 559; Lowe and Fet, 2000: 44.

Urophonius brachicentrus bivittatus: Mello-Leitão, 1939: 612; Abalos, 1959: 592; 1963: 117; Roig Alsina, 1973: 200 [incorrect subsequent spelling].

Fig. 5. Most parsimonious tree (length = 167; CI: 0.479; RI: 0.813), obtained by cladistic analysis of 65 morphological characters (appendix 2) scored for 15 species of *Orobothriurus* Maury, 1976, and 15 outgroup taxa with the implied weighting regime that maximized average support (Mattoni et al., in litt.). Synapomorphies optimized with accelerated transformation indicated with bars. Black bars indicate uniquely derived apomorphic states, white bars indicate parallel derivations of apomorphic states. Numbers above bars indicate characters, numbers below indicate states.

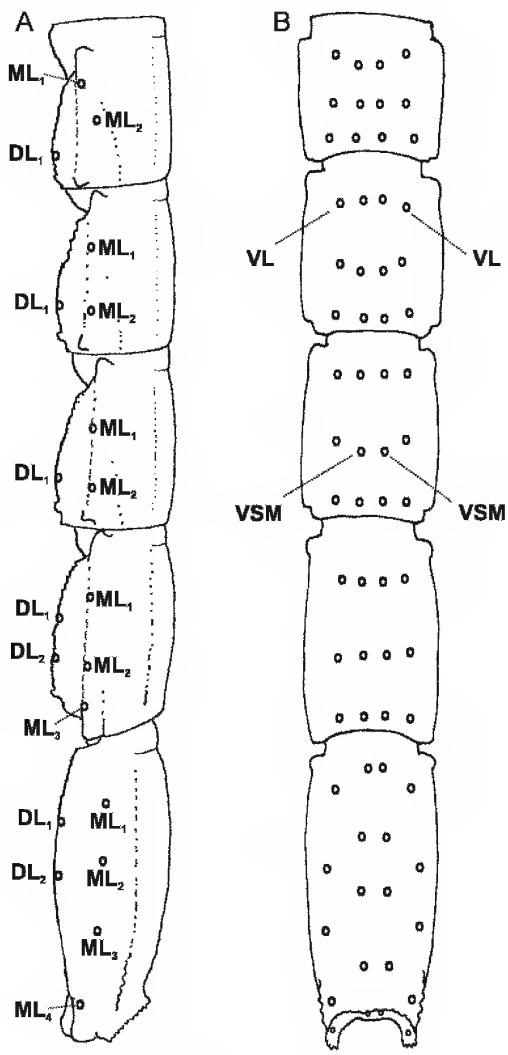

Fig. 6. *Orobothriurus* Maury, 1976, metasomal segments I–V showing distribution of macrosetae. **A.** Lateral aspect. **B.** Ventral aspect. Annotations: dorsolateral (DL); median lateral (ML); ventrolateral (VL); ventrosubmedian (VSM).

Orobothriurus bivitattus: Acosta, 2005: 3–12, figs. 1–8; Ojanguren Affilastro, 2005: 181–183, 220, 241; Acosta, 2006: 20, 21; ICZN, 2008: 69–70.

Orobothriurus alticola: Maury, 1976: 17–18, figs. 1–10, table 1 (part); 1979: 717, map 10 (part); 1981: 98 (part); Acosta and Maury, 1998: 559 (part); Kovařík, 1998: 101; Acosta and Ochoa, 2000: 135, 136, 143; Lowe and Fet, 2000: 35; Acosta and Ochoa, 2001: 203–205, 208, 209; Acosta, 2002: 176, 177; Ochoa, 2004a: 44, 49, 50, 52, 55, figs. 1, 2, 21, table 1; Acosta, 2005: 1, 2, 8, 9, 12; Ojanguren Affilastro, 2005: 176, 178, 179, 180, 220, 241; Kamenz and Prendini, 2008: 39, pl. 111, table II; Ojanguren Affilastro et al., 2009: 35–40, figs. 2, 18, 19, 25–35, table 2.

TYPE MATERIAL: **ARGENTINA: Mendoza Province:** *Las Heras Department*: 1 ♂, 1 ♀ syntypes (BMNH), Puente del Inca [32°49′09.15″S 69°55′01.82″W, 2721 m]. *Cercophonius brachycentrus bivittatus*: 1 juv. holotype (NRS), **San Juan Province**.

NEW RECORDS: **ARGENTINA: Mendoza Province:** *Las Heras Department*: Puente del Inca, 32°49.568′S 69°54.606′W, 2759 m, 2.xi.2003, J.A. Ochoa, L. Prendini and C.I. Mattoni, alpine vegetation (low spiny bushes) on hard, rocky ground, under stone, 1 juv. (AMNH [LP 2386]). **San Juan Province:** *Calingastra Department*: Cerro el Tontal, 31°31′24.7″S 69°12′23.3″W, 3600 m, 25.i.2006, A. Ojanguren Affilastro, L. Compagnucci and L. Piacentini, 2 juv. (AMNH [LP 5848]); between Paso de Agua Negra and Aduana, vega and surrounds, 30°17′33.1″S 69°46′45.6″W, 4005 m, 27.i.2005, C.I. Mattoni and A. Ojanguren Affilastro, UV sampling, 1 subad. ♂, 1 subad. ♀, 1 juv. ♂ (AMNH [LP 4309]).

DIAGNOSIS: *Orobothriurus alticola* is similar to *O. grismadoi* in pigmentation pattern, external morphology, and hemispermatophore. The two species can be separated by the shape of the hemispermatophore: the apex is narrower, and the angle formed by the apex with the rest of the distal lamina smaller in *O. grismadoi* (fig. 36D, E) than in *O. alticola* (fig. 36I, J). Males can also be separated by the shape of the telson, which is more slender in *O. grismadoi*. Additionally, the dorsal surface of the telson vesicle is concave in males of *O. grismadoi*, whereas it is flat in males of *O. alticola* (fig. 23A, E). Tergite VII is almost entirely pigmented, without an unpigmented median stripe, in *O. grismadoi* (fig. 13G), but exhibits paired lateral spots of pigmentation, delimiting an unpigmented median stripe, in *O. alticola* (fig. 13F). On the other hand, *O. alticola* can be separated from *O. compagnuccii* by the shape of the lamina of the hemispermatophore: the apex comprises 52.17%–54.54% (n = 3; mean = 52.98%) of the lamina in *O. compagnuccii* and 40.87%–46.08% (n = 20; mean = 43.88%) in *O. alticola*. *Orobothriurus alticola* and *O. ramirezi* can be separated by

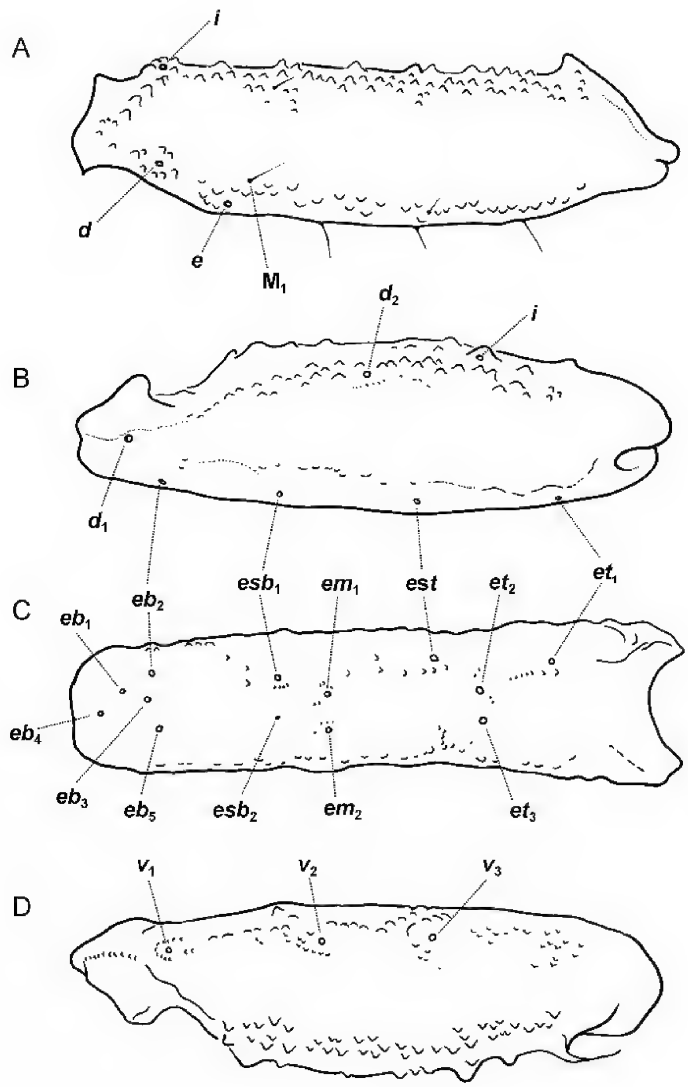

Fig. 7. *Orobothriurus* Maury, 1976, dextral pedipalp femur (**A**) and patella (**C–D**), showing trichobothrial pattern. **A.** Femur, dorsal aspect. **B.** Patella, dorsal aspect. **C.** Patella, external aspect. **D.** Patella, ventral aspect. Annotations: dorsal (*d*); external (*e*); external basal (*eb*); external medial (*em*); external suprabasal (*esb*); external subterminal (*est*); external terminal (*et*); internal (*i*); ventral (*v*). Scale bar = 1 mm.

the distal crest of the hemispermatophore, which is less developed, occupying only half the apex of the lamina, in *O. alticola*, than in *O. ramirezi*, in which it occupies almost the entire apex (figs. 36I, J, 47A, B). The telson vesicle of *O. alticola* is narrower, especially in females (telson length/width ratio: ♂, 2.87–3.21, mean = 3.07; ♀, 2.44–2.55, mean = 2.49; fig. 23A) than that of *O. ramirezi* (telson length/width ratio: ♂, 2.65–2.94, mean = 2.78; ♀, 2.13–2.37, mean = 2.27; figs. 23G, 24E). The dorsal surface of the femur and ventral surface of the metasoma are less pigmented, with narrower stripes, in *O. alticola* than *O. ramirezi*. The metasomal carinae, especially the VL and VSM carinae of segments I and V, and the DL carinae of segment V, are less developed in males of *O. alticola* than *O. ramirezi* (fig. 20A, C).

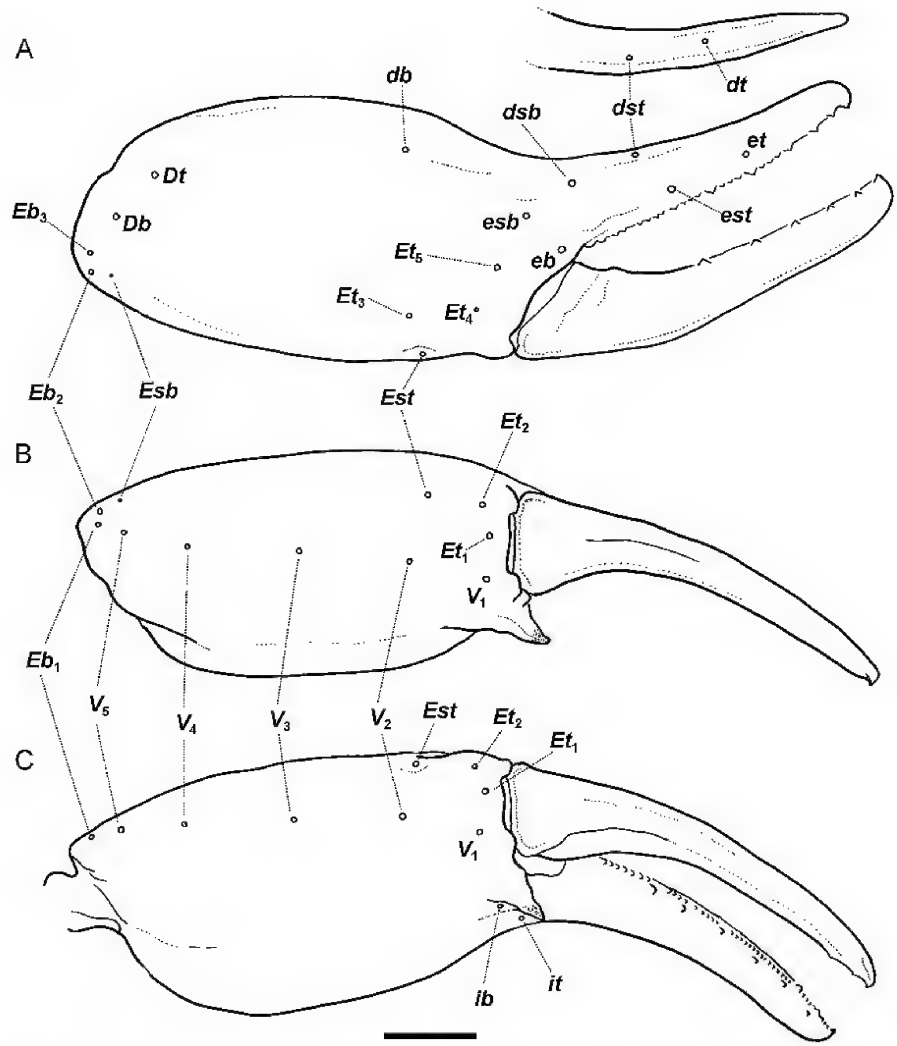

Fig. 8. *Orobothriurus* Maury, 1976, dextral pedipalp chela, showing trichobothrial pattern. **A.** External aspect, with dorsal aspect of fixed finger. **B.** Ventral aspect. **C.** Ventrointernal aspect. Annotations: dorsal basal (*db*, *Db*); dorsal suprabasal (*dsb*); dorsal subterminal (*dst*); dorsal terminal (*dt*, *Dt*); external basal (*eb*, *Eb*); external suprabasal (*esb*, *Esb*); external subterminal (*est*, *Est*); external terminal (*et*, *Et*); internal basal (*ib*); internal terminal (*it*); ventral (*V*). Scale bar = 1 mm.

REMARKS: Acosta (2002) transferred *Cercophonius brachycentrus bivittatus* to *Orobothriurus*, and subsequently redescribed it as a valid species based on a single male specimen (Acosta, 2005). Based on an examination of additional material, however, Ojanguren Affilastro et al. (2009) were unable to identify any characters by means of which this species could be consistently separated from *O. alticola*, and it was therefore synonymized.

DISTRIBUTION: *Orobothriurus alticola* is endemic to central-western Argentina, from the central part of Mendoza Province (Laguna Diamante) to the central part of San Juan Province (Paso del Agua Negra; fig. 54). It occurs at 2700–4000 m in the Andes (fig. 3B) and nearby El Tontal mountain range of the Precordillera (fig. 3C, Ojanguren Affilastro et al., 2009).

ECOLOGY: The area inhabited by *O. alticola* belongs to the Puna and the Altoandina

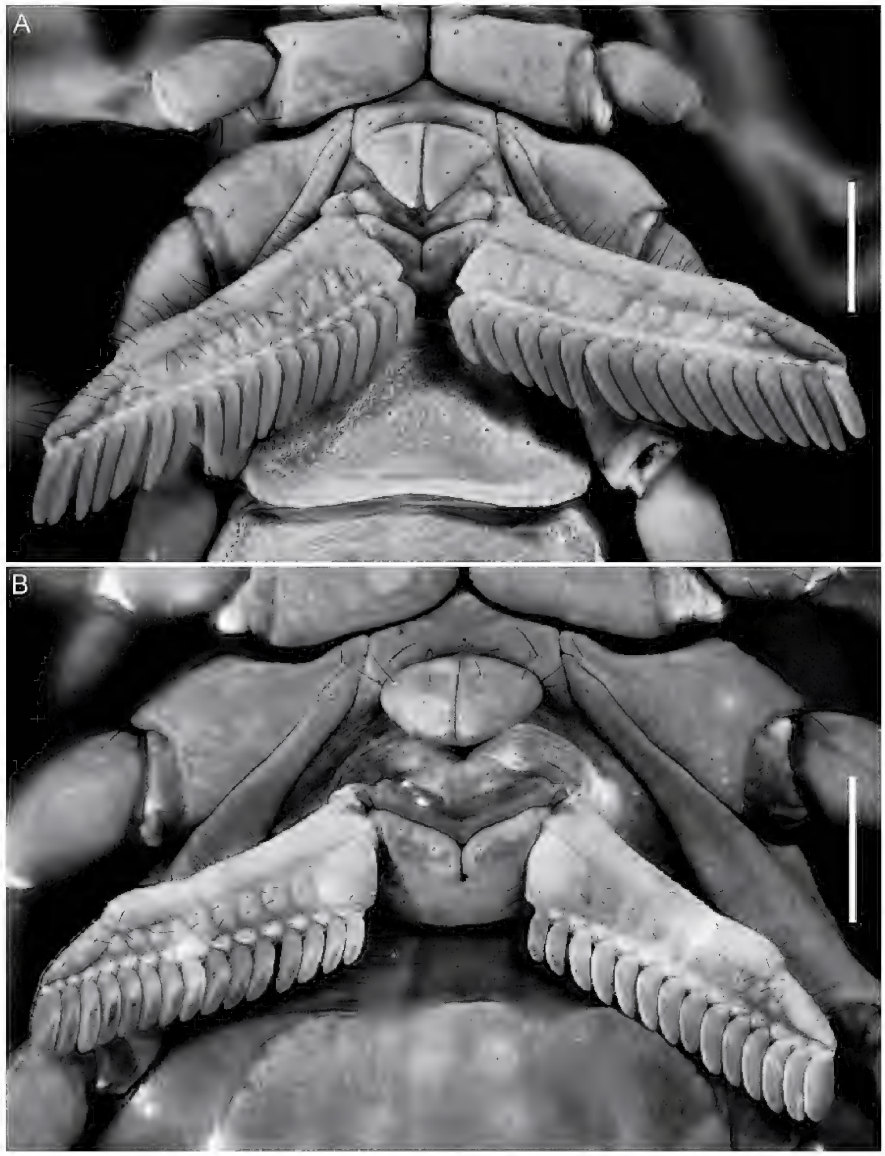

Fig. 9. *Orobothriurus parvus* Maury, 1976, sternum and pectines. **A.** ♂ (MHNC). **B.** ♀ (MHNC). Scale bars = 1 mm.

phytogeographic provinces (Cabrera and Willink, 1980). This species was collected in sympatry with another bothriurid, *Brachistosternus montanus* Roig Alsina, 1977.

Orobothriurus ampay
Ochoa and Acosta, 2003
Figures 4A, 11A, 12D, 17B, 22A, 25A, 27A, 52

Orobothriurus ampay Ochoa and Acosta, 2003: 2–6, figs. 1–14; Ochoa, 2004a: 43, 52, 54, 73, figs. 1, 2, 21, table 1; 2005: 55, figs. 7, 9, table 2.

TYPE MATERIAL: **PERU: Apurímac Department:** *Abancay Province*: Holotype ♂ (MUSM), Tamburco, Sector Arapato, Santuario Nacional Ampay, 13°35′S 72°52′W, 3580 m, 25.viii.1998, R. Aimituma. Paratypes: Santuario Nacional Ampay, Bosque Nativo del Ampay [13°35′41″S 72°52′48″W], 3100–3300 m, 26.viii.1998, J.C. Chaparro and J.A. Ochoa, 2 ♀ (MHNC), 1 ♀ (CDA 088), 1 ♀ (MACN-Ar 10039); Santuario Nacional Ampay, Ccorhuani [ca. 13°35′S

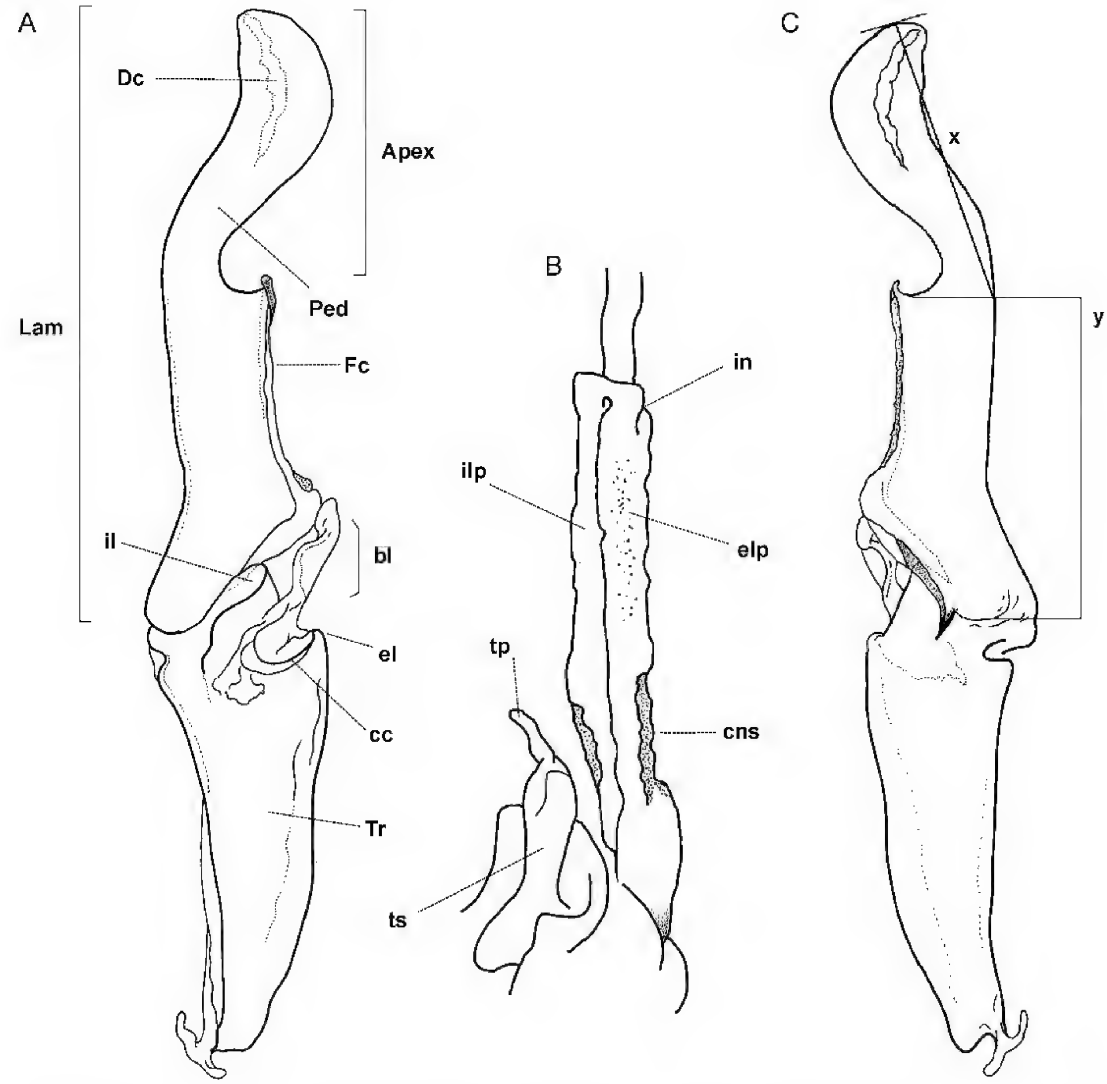

Fig. 10. *Orobothriurus* Maury, 1976. Sinistral hemispermatophore showing morphology and measurements. **A.** Ental aspect. **B.** Dorsal aspect. **C.** Ectal aspect. Annotations: basal lobe (bl); capsular concavity (cc); constriction (cns); distal crest (Dc); external lobe (el); external lateral projection (elp); frontal crest (Fc); internal lobe (il); internal lateral projection (ilp); incision (in); Lamina (Lam); pedicel (Ped); terminal process (tp); trunk (Tr); tortuous stem (ts); apex length (x); length of basal portion of lamina (y).

72°52′W], 3280 m, 18.ix.1998, R. Aimituma, 1 ♀ (MUSM).

NEW RECORDS: **PERU: Apurímac Department:** *Abancay Province*: Santuario Nacional Ampay, Bosque Nativo del Ampay, 13°35′S 72°52′W, 3200 m, 17.vii.2000, J.A. Ochoa, in *Podocarpus glomeratus* forest, 1 ♀ (AMNH [LP 1918]).

DIAGNOSIS: *Orobothriurus ampay* differs from all other species in the genus by its well-developed pigmentation pattern. The tergites of this species are entirely, densely pigmented (fig. 12D) and the paired VL stripes contiguous with the VM stripe posteriorly on metasomal segments I–V (fig. 11A) whereas, in other species, tergites I–VI each possess two lateral spots delimiting an unpigmented median stripe along the mesosoma (fig. 13E–G) and the paired VL stripes of the metasomal segments are not contiguous with the VM

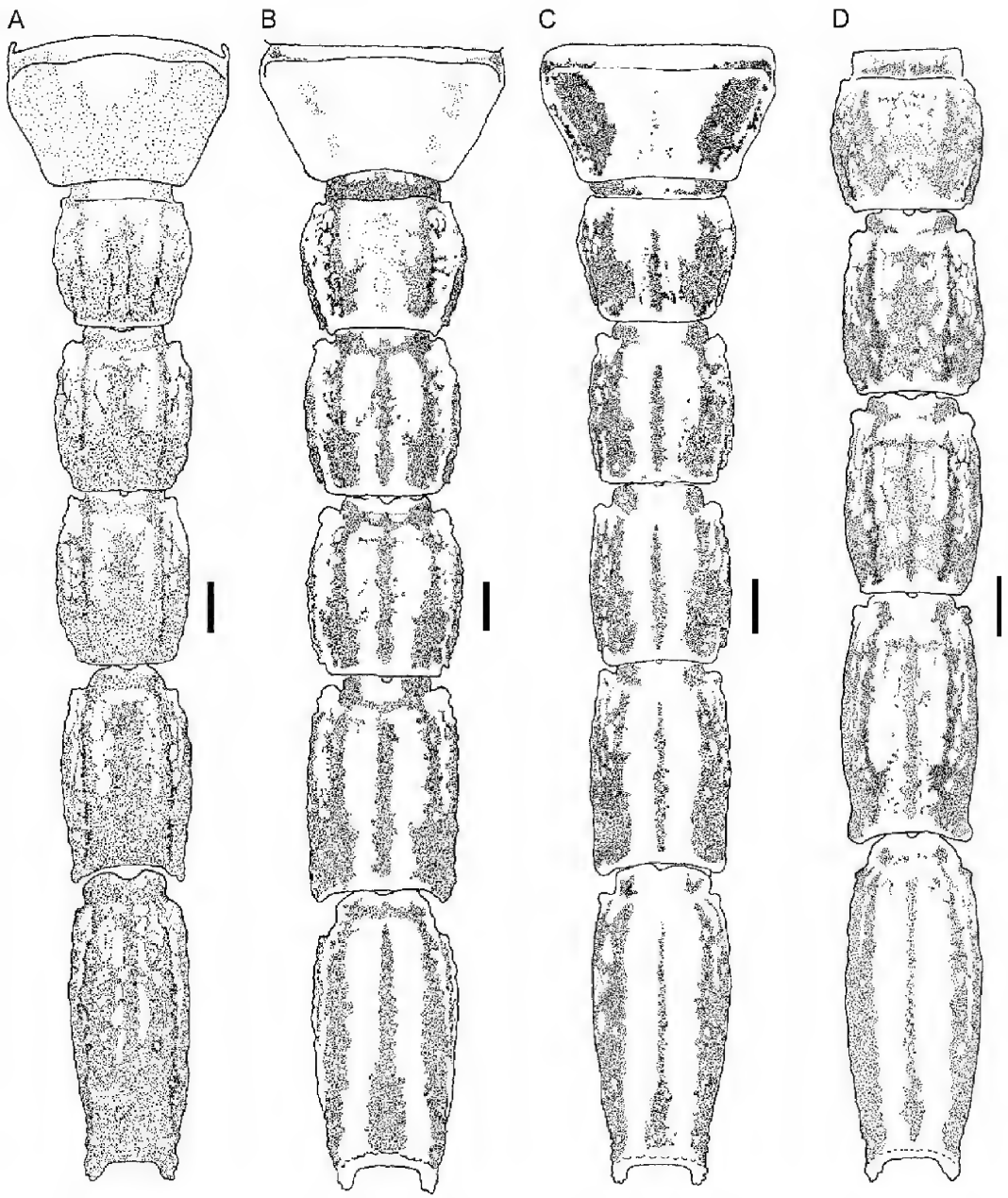

Fig. 11. *Orobothriurus* Maury, 1976, sternite VII and metasomal segments I–V, ventral aspect, showing pigmentation pattern. **A.** *Orobothriurus ampay* Ochoa and Acosta, 2003, allotype ♀ (MUSM). **B.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♀ (MHNC). **C.** *Orobothriurus huascaran*, n. sp., paratype ♀ (MHNC). **D.** *Orobothriurus atiquipa* Ochoa and Acosta, 2002, ♂ paratype (MHNC). Scale bars = 1 mm.

stripe posteriorly, at least on segments IV and V (figs. 11B–D, 13A, D). *Orobothriurus ampay* may be further distinguished on the basis of metasomal carination, trichobothriotaxy and pedipalp chela ornamentation. The VSM carinae, present on metasomal segment IV in *O. ampay* (fig. 17B), are absent in other species of *Orobothriurus* (fig. 17A). The angle formed between pedipalp chela trichobothria *eb*–Et_5–Et_4 is less than 90° in *O. ampay*

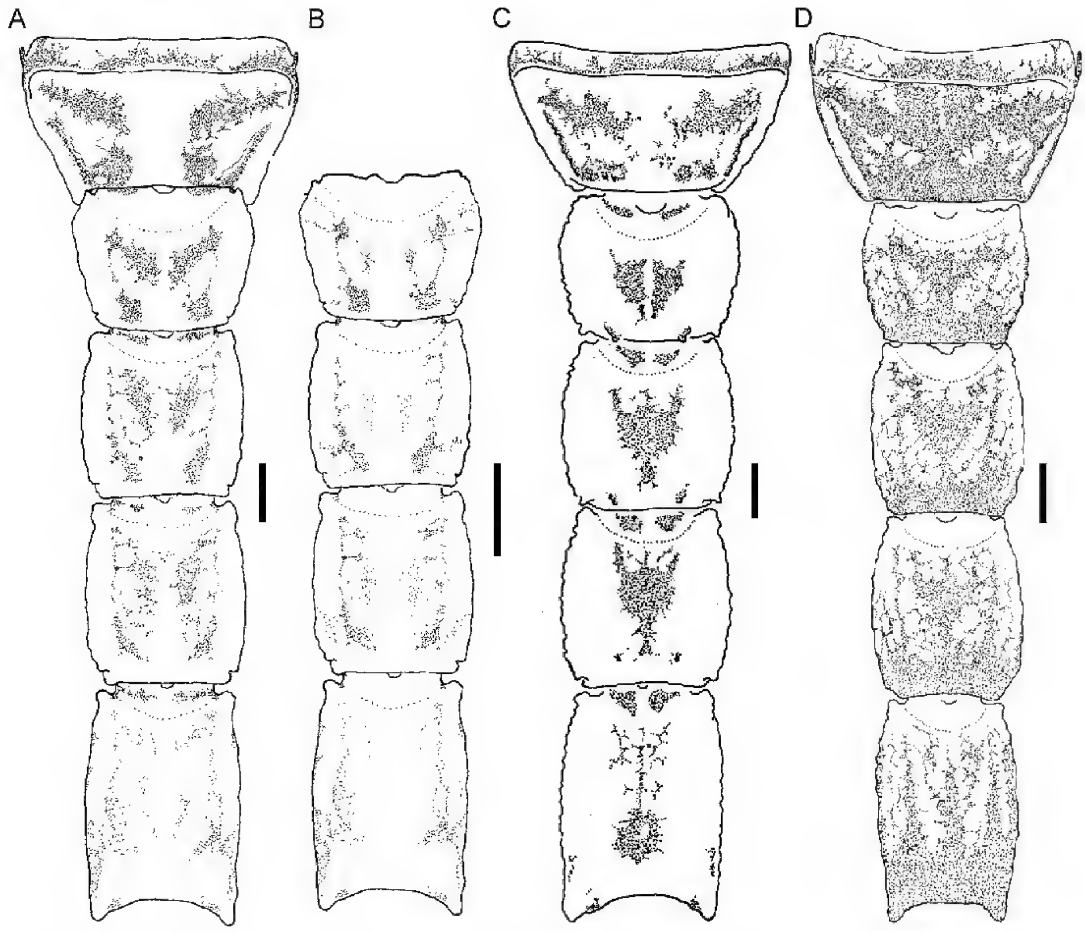

Fig. 12. *Orobothriurus* Maury, 1976, tergite VII (**A**, **C**, **D** only) and metasomal segments I–IV, dorsal aspect, showing pigmentation pattern. **A.** *Orobothriurus huascaran*, n. sp., paratype ♀ (MHNC). **B.** *Orobothriurus parvus* Maury, 1976, ♀ (MHNC). **C.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♀ (MHNC). **D.** *Orobothriurus ampay* Ochoa and Acosta, 2003, allotype ♀ (MUSM). Scale bars = 1 mm.

(fig. 25A), but greater than 90° in other species (figs. 25B, D, 26B, C). The acuminate conical apophysis on the internal surface of the male pedipalp chela manus, observed in all other *Orobothriurus* species (except *O. wawita*, in which it is absent altogether), is reduced to a few granules in *O. ampay*. The hemispermatophore of *O. ampay* resembles that of *O. parvus* and *O. wawita* in possessing an elongated apex and a short frontal crest, which is less than half the length of the lamina. However, the ventral margin of the apex is inclined to the dorsal surface and curved distally in *O. ampay* (fig. 27A) and *O. parvus* (fig. 27B), but straight in *O wawita* (fig. 27C). Finally, *O. ampay* possesses the lowest pectinal tooth count in the genus (12–15).

DISTRIBUTION: *Orobothriurus ampay* is known only from the Santuario Nacional Ampay, near Abancay in the Apurímac Department of southeastern Peru, at 3100–3580 m (figs. 3E, 52).

ECOLOGY: *Orobothriurus ampay* appears to be endemic to an inter-Andean forest of *Podocarpus glomeratus* Don (Podocarpaceae) (fig. 3E). All known records of this species were collected inside the forest under stones on moist soil. No other scorpion species are known from this forest. The closest records are two other bothriurids, *Brachistosternus peruvianus* Piza, 1974, and *Pachakutej iskay*

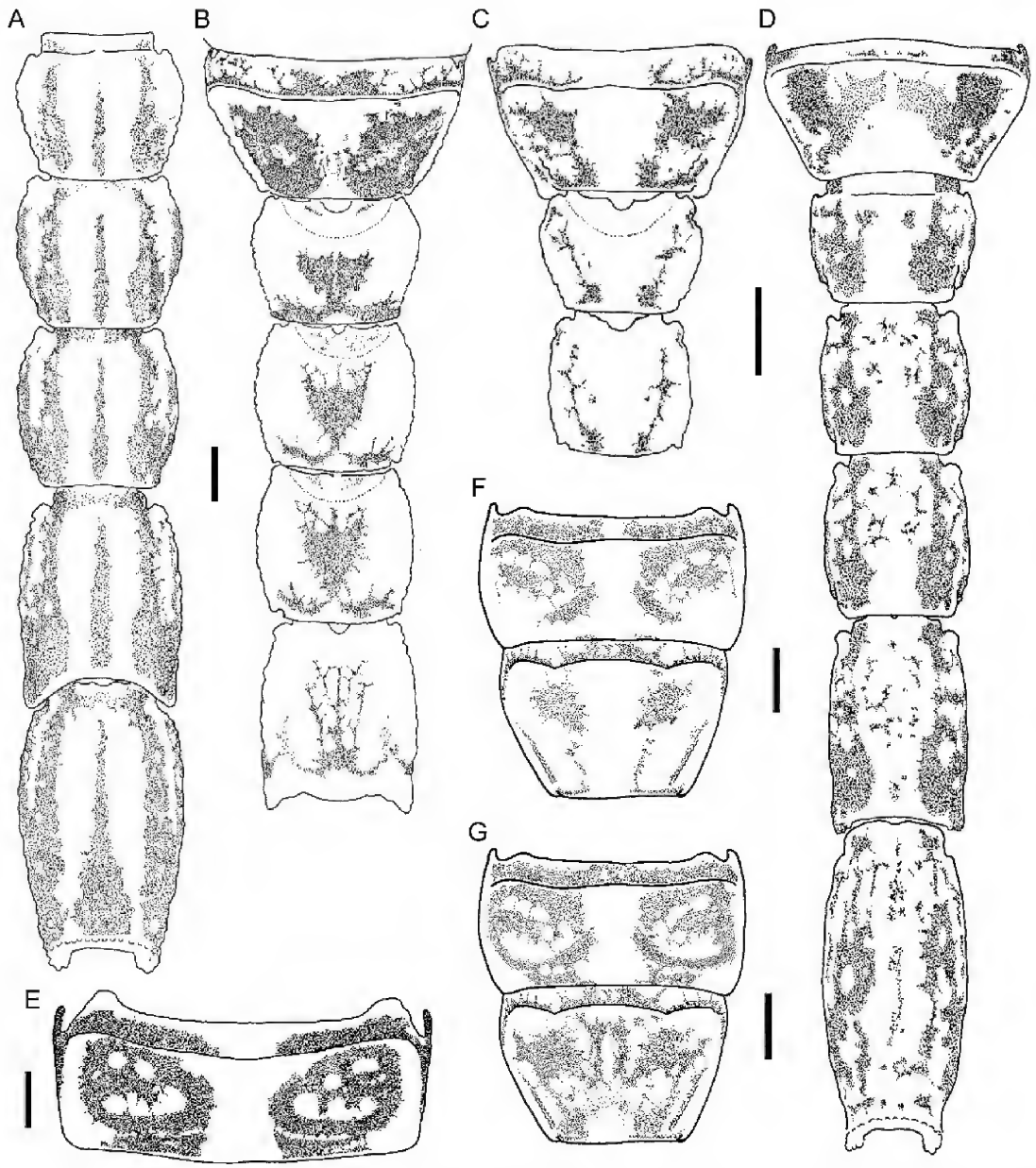

Fig. 13. *Orobothriurus* Maury, 1976, tergites, sternites and metasomal segments I–V, showing pigmentation pattern. **A, B.** *Orobothriurus paessleri* (Kraepelin, 1911), ♀ (MHNC), metasomal segments I–V, ventral aspect (**A**), tergite VII and metasomal segments I–IV, dorsal aspect (**B**). **C, D.** *Orobothriurus wawita* Acosta and Ochoa, 2000, ♀ (MHNC), tergite VII and metasomal segments I and II, dorsal aspect (**C**), sternite VII and metasomal segments I–V, ventral aspect (**D**). **E.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♀ (MHNC), tergite V, dorsal aspect. **F.** *Orobothriurus alticola* (Pocock, 1899), ♀ (MACN-Ar), tergites VI and VII, dorsal aspect. **G.** *Orobothriurus grismadoi* Ojanguren-Affilastro et al., 2009, tergites VI and VII, dorsal aspect. Scale bars = 1 mm.

(Acosta and Ochoa, 2001), and a buthid, *Tityus footei* Chamberlin, 1916, which inhabit an adjacent dry valley in Tamburco.

Orobothriurus atiquipa
Ochoa and Acosta, 2002
Figures 11D, 18A, 21A, 25D, 28A, 53

Orobothriurus atiquipa Ochoa and Acosta, 2002a: 99–102, figs. 1–9, table 1; Ojanguren Affilastro, 2003a: 121, fig. 14; Ochoa, 2004a: 43, 52, 55, 73, figs. 1, 2, 21, table 1; 2005: 55, figs. 7, 9, table 2; Rein, 2007: 5.

Orobothriurus aff. *paessleri*: Lourenço and Dastych, 2001: 54 [probable misidentification: specimens from Chala].

Orobothriurus paessleri: Lourenço and Dastych, 2001: 54 [probable misidentification: specimens from Atico and Road between Chala and Cháparra].

TYPE MATERIAL: **PERU: Arequipa Department:** *Caraveli Province*: Holotype ♂ (MACN-Ar 10010), paratype ♂ (MHNC), Lomas Atiquipa, Cerro Lloque, 15°45′S 74°22′W, 950 m, 13.ix.1999, H. Zeballos and R. Gutiérrez.

NEW RECORDS: **PERU: Arequipa Department:** *Caraveli Province*: Lomas Atiquipa, Sector Conchara, 15°46′16″S 74°22′42″W, 750 m, 6.iii.2004, J.L. Velasquez and J.A. Ochoa, 3 ♂, 3 juv. (MHNC), 2 juv. (AMNH [LP 3056]).

DIAGNOSIS: *Orobothriurus atiquipa* may be distinguished from all other species of the genus by means of the telotarsal setation of the legs and the granulation on the ventral surface of metasomal segment V. In *O. atiquipa*, the telotarsi of legs III and IV each possess 3/4 spiniform macrosetae in the pro- and retroventral rows, and the VSM and VM carinae are not discernible from the dense granulation on the ventral surface of segment V (fig. 21A) whereas, in other species of *Orobothriurus*, the telotarsi of legs III and IV each possess 3/3 spiniform macrosetae in the pro- and retroventral rows, and the VM and VL carinae are well defined on segment V (figs. 20A, D, E, 21D). Additionally, the hemispermatophore of *O. atiquipa* is proportionally longer than that of all other species. This species possesses the most elongated frontal crest in the genus (fig. 28A).

DISTRIBUTION: *Orobothriurus atiquipa* is known only from the type locality in northern Arequipa Department, southern Peru, at 750–950 m (figs. 2D, 53).

ECOLOGY: Lomas biotopes are isolated patches of green vegetation on hillsides below 1000 m, surrounded by hyperarid desert, along the western coast of southern Peru and northern Chile (fig. 2D). Climatic patterns produce fog zones that allow plant communities to exist in areas where the rainfall is very low. The flora and fauna of Lomas have closer affinities with that of the high Andean peaks than the surrounding desert biota (Herrera, 1930; Péfaur, 1981; Ochoa, 2005). The vegetation in the habitat of *O. atiquipa* is characterized by shrubs, herbaceous plants, and trees like *Myrcianthes ferreyrae* (McVaugh) McVaugh (Myrtaceae), *Caesalpinia spinosa* (Molina) Kuntze (Fabaceae), *Acacia macracantha* Humboldt and Bonpland ex Willdenow (Fabaceae), and *Carica candicans* A. Gray (Caricaceae). An iurid in the genus *Hadruroides* was recorded in sympatry with *O. atiquipa* (Ochoa and Prendini, 2010).

REMARKS: Specimens from three localities (Atico, Chala and Road between Chala and Cháparra) in the Arequipa Department, Peru, were listed under *O. paessleri* and "*O.* aff. *paessleri*" by Lourenço and Dastych (2001: 54), who noted that the specimens from Chala are "possibly a new species." Although we have not examined these specimens, they are probably conspecific with *O. atiquipa*, not *O. paessleri*, based on the known distribution of this species.

Orobothriurus calchaqui, n. sp.
Figures 14A, 18B, 21D, 23B, 24A, 29–31, 32A, B, 36K–O, 54; table 3

Orobothriurus alticola: Maury, 1976: 18 (part) [misidentification].

TYPE MATERIAL: **ARGENTINA: Tucumán Province:** *Tafí del Valle Department*: Holotype ♂ (MACN-Ar), El Infiernillo (Tafí del Valle), 26°44′13.3″S 65°45′51.2″W, 2700 m, 30.x.2004, A. Ojanguren Affilastro and L. Compagnucci. Paratypes: same data, 20 ♂, 2 ♀ (MACN-Ar), 2 ♂ (AMNH), 2 ♂ (AMNH [LP 5195]), 2 ♂ (LBRE), 2 ♂ (MHNC); Cumbres Calchaquies, Huaca Huasi, 4250 m, E. Domínguez, 1 ♀ (MACN-Ar); Vaca Huasi, 4300 m, 16.xi.1974, S. Hallow, 1 ♀ (MACN-Ar).

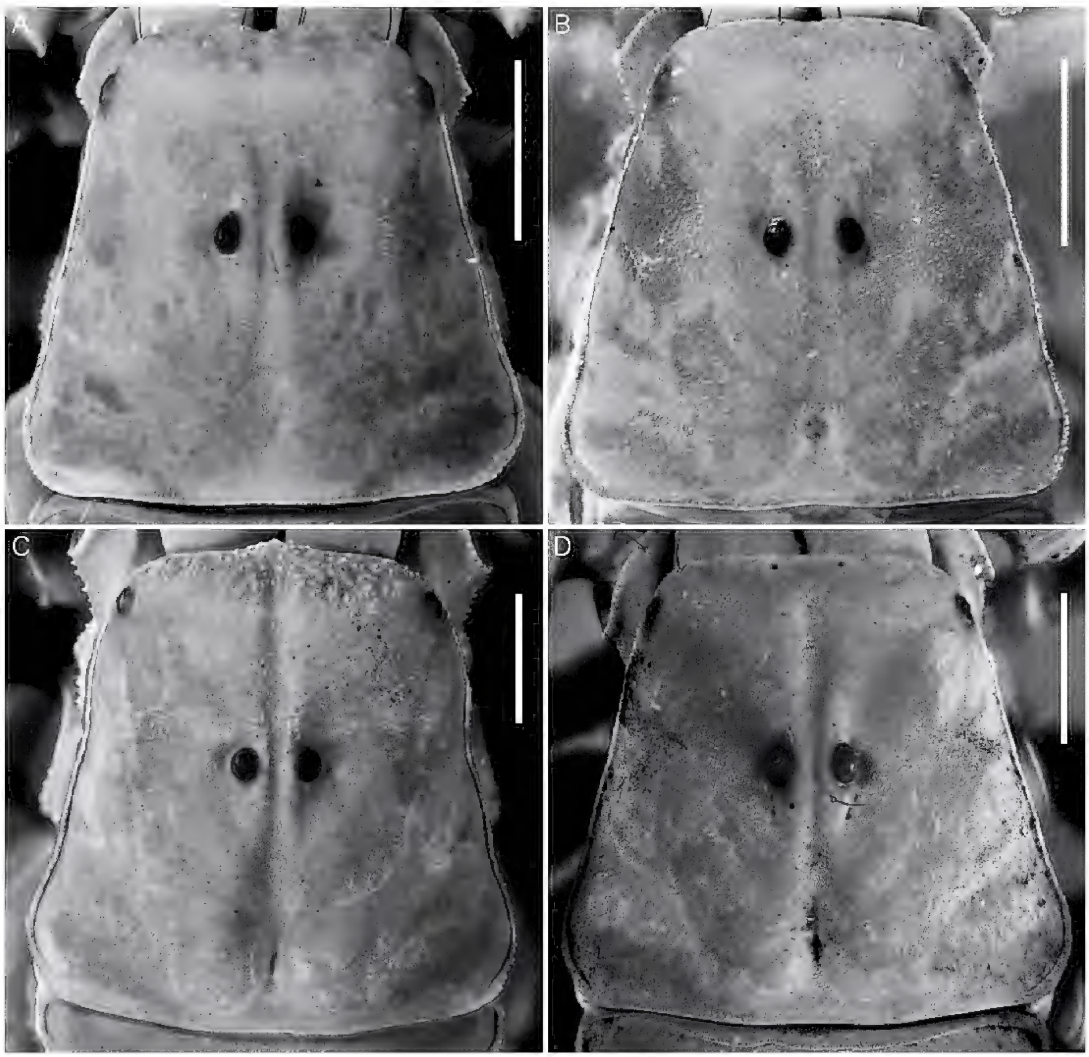

Fig. 14. *Orobothriurus* Maury, 1976, carapace, dorsal aspect. **A.** *Orobothriurus calchaqui*, n. sp., paratype ♂ (MACN-Ar). **B.** *Orobothriurus compagnuccii*, n. sp., paratype ♂ (MACN-Ar). **C.** *Orobothriurus curvidigitus*, ♂ (MHNC). **D.** *Orobothriurus huascaran*, n. sp., paratype ♂ (MACN-Ar). Scale bars = 1 mm.

ETYMOLOGY: The specific name is a noun in apposition referring to the Cumbres Calchaquies mountain range in the Andes, where this species occurs.

DIAGNOSIS: *Orobothriurus calchaqui* is most closely related to *O. famatina* (fig. 5). The two species can be separated by a combination of characters, several of which overlap in some specimens. *Orobothriurus calchaqui* possesses two or three ML macrosetae on metasomal segment IV, and 70% of specimens possess one DL macroseta on segment III (absent in 30%), whereas *O. famatina* possesses one ML macroseta on segment IV and only 10% of specimens possess one DL macroseta on segment III (absent in 90%). There are also differences in the trichobothrial pattern. Pedipalpal chela trichobothria *db* and Et_3 are always located proximal to *Est* in *O. calchaqui* (fig. 31C) whereas, in *O. famatina*, *db* is located in the same axis as Et_3 (in 70% of the specimens) or

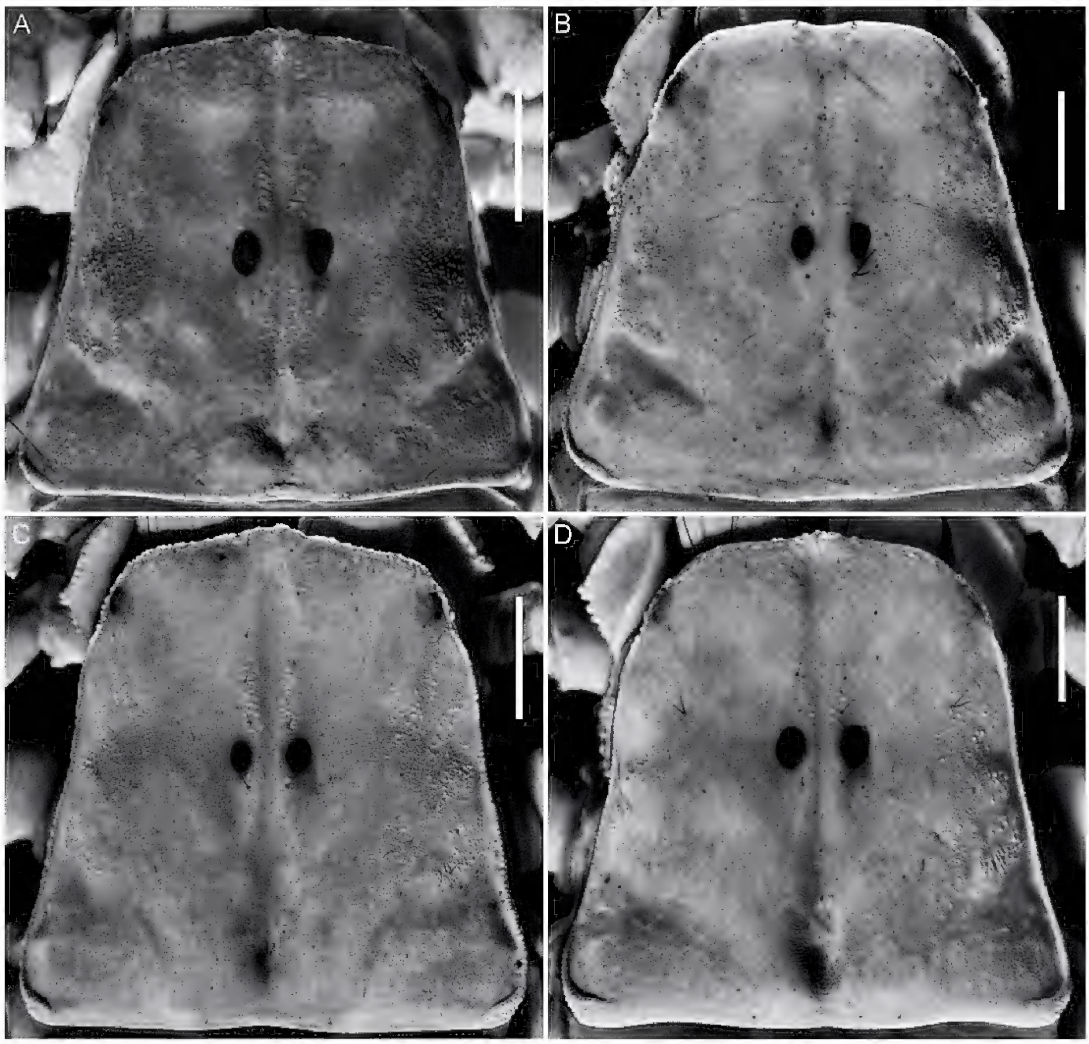

Fig. 15. *Orobothriurus* Maury, 1976, carapace, dorsal aspect. **A.** *Orobothriurus paessleri* (Kraepelin, 1911), ♂ (CDA 186). **B.** *Orobothriurus alticola* (Pocock, 1899), ♂ (AMNH). **C.** *Orobothriurus quewerukana*, n. sp., paratype ♂ (AMNH). **D.** *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar). Scale bars = 1 mm.

slightly distal to it (30%). Pedipalp patella trichobothrium em_2 is located proximal to em_1 in 80% of the specimens of *O. calchaqui* (fig. 30C), but in the same axis as, or distal to em_1 in 70% of the specimens of *O. famatina*. There are also slight differences in the shape of the hemispermatophore in most specimens. The pedicel of the apex is usually narrower and the angle formed by the apex with the rest of the distal lamina usually greater in *O. calchaqui* than *O. famatina* (fig. 36F–H, K–M). However, the hemispermatophore of some specimens of *O. calchaqui* is indistinguishable from that of *O. famatina* (fig. 36N, O).

DESCRIPTION: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 23–30 mm (n = 10, mean = 25.9 mm); ♀, 33.5–36 mm (n = 4, mean = 34.45 mm).

Color: General color yellowish with dark brown spots (fig. 29). Carapace, anterior margin faintly pigmented; lateral margins with two large spots medially and posteriorly, remaining area with reticulate pigmentation;

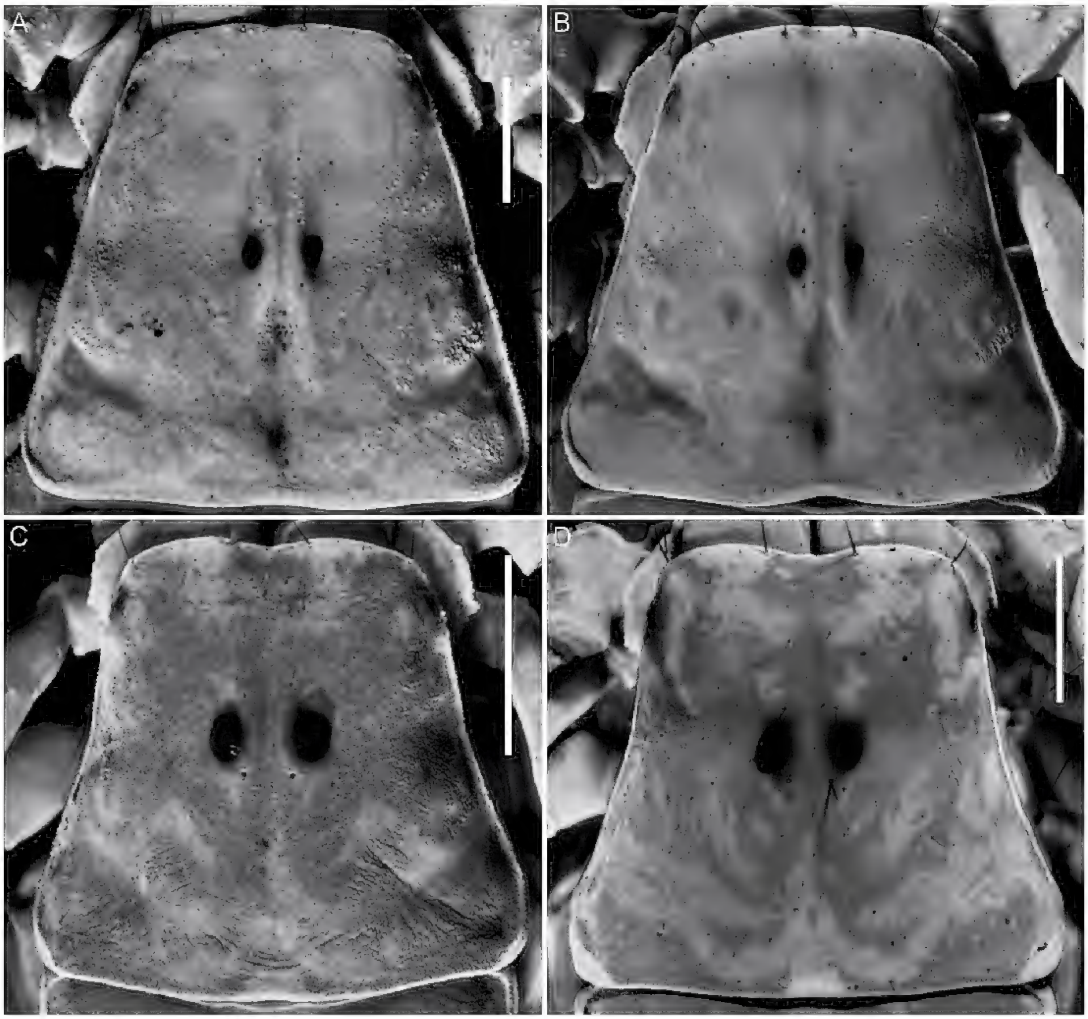

Fig. 16. *Orobothriurus* Maury, 1976, carapace, dorsal aspect. **A, B.** *Orobothriurus ramirezi*, n. sp. **A.** Holotype ♂ (MACN-Ar). **B.** Paratype ♀ (MACN-Ar). **C, D.** *Orobothriurus wawita* Acosta and Ochoa, 2000. **C.** Paratype ♂ (CDA 019). **D.** Paratype ♀ (CDA 019). Scale bars = 1 mm.

median ocular tubercle and lateral ocelli dark brown to black; posterior half of anteromedian longitudinal sulcus, median ocular tubercle, and postocular sulcus pigmented. Chelicerae, distal surface of manus, and movable finger with reticulate pigmentation. Pedipalp coxa and trochanter faintly pigmented; femur densely pigmented near articulation with patella; patella densely pigmented near articulations; chela manus with six complete longitudinal stripes along carinae, contiguous at base of movable finger; fingers and articulation of fingers pigmented. Legs, femur, patella, tibia, and basitarsus faintly pigmented, especially near articulations and along dorsal margin. Tergites I–VI each with two dark spots sublaterally along almost entire margin, broader near anterior margin, delimiting broad, unpigmented median stripe (fig. 29A, B); VII with four dark spots, two larger spots posterolaterally, occupying area between dorsolateral carinae and external margins of sclerite, and two small dark triangular spots submedially, extending along submedian carinae, delimiting unpigmented median stripe. Sternum, genital opercula and pectines unpigmented. Sternites III–VI usually unpigmented, but lateral margins of segments V and VI faintly pigmented in some specimens; VII with two narrow dark stripes

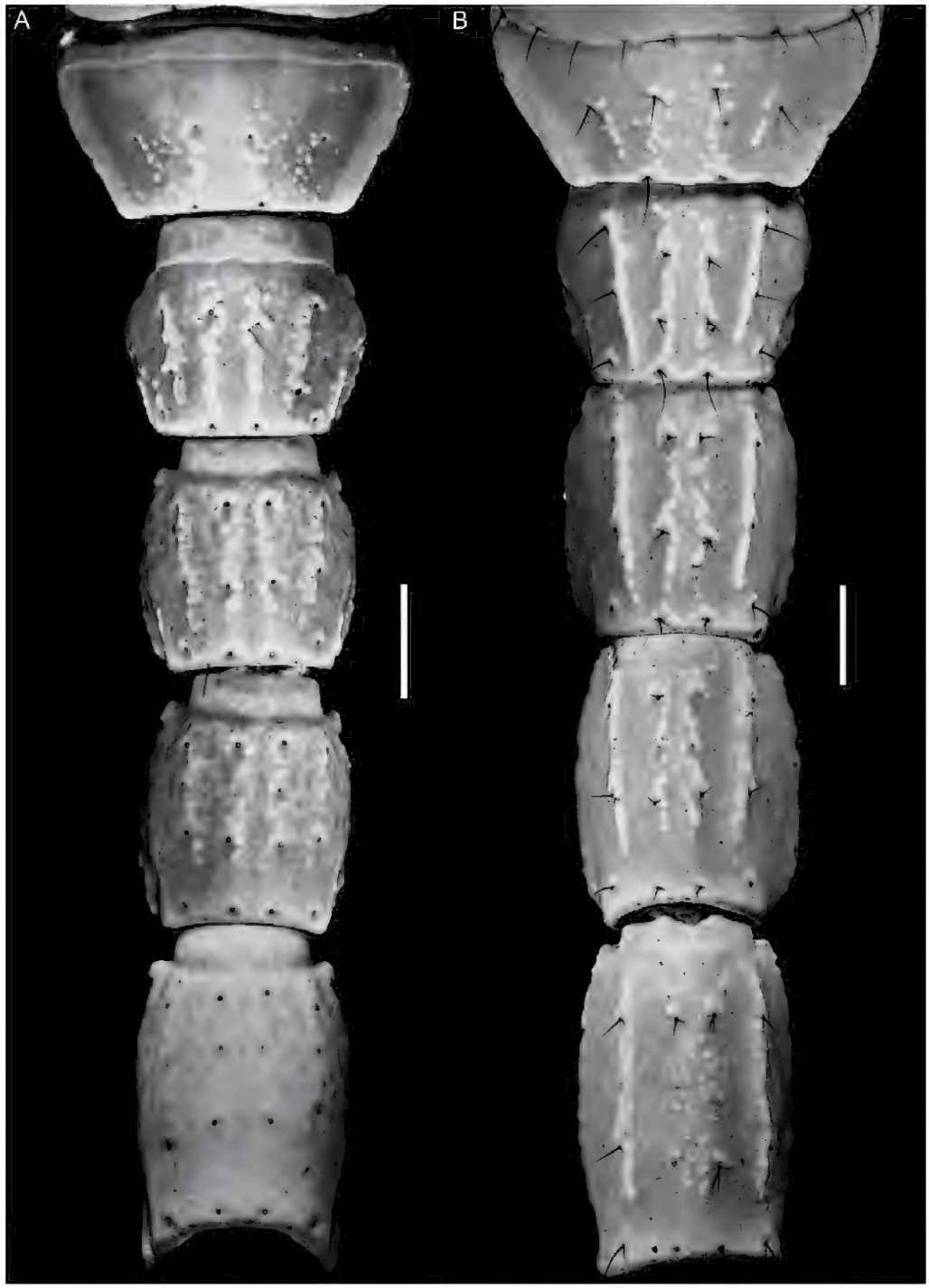

Fig. 17. *Orobothriurus* Maury, 1976, sternite VII and metasomal segments I–IV, ventral aspect. **A.** *Orobothriurus parvus* Maury, 1976, ♀ (MHNC). **B.** *Orobothriurus ampay* Ochoa and Acosta, 2003, paratype ♀ (MHNC). Scale bars = 1 mm.

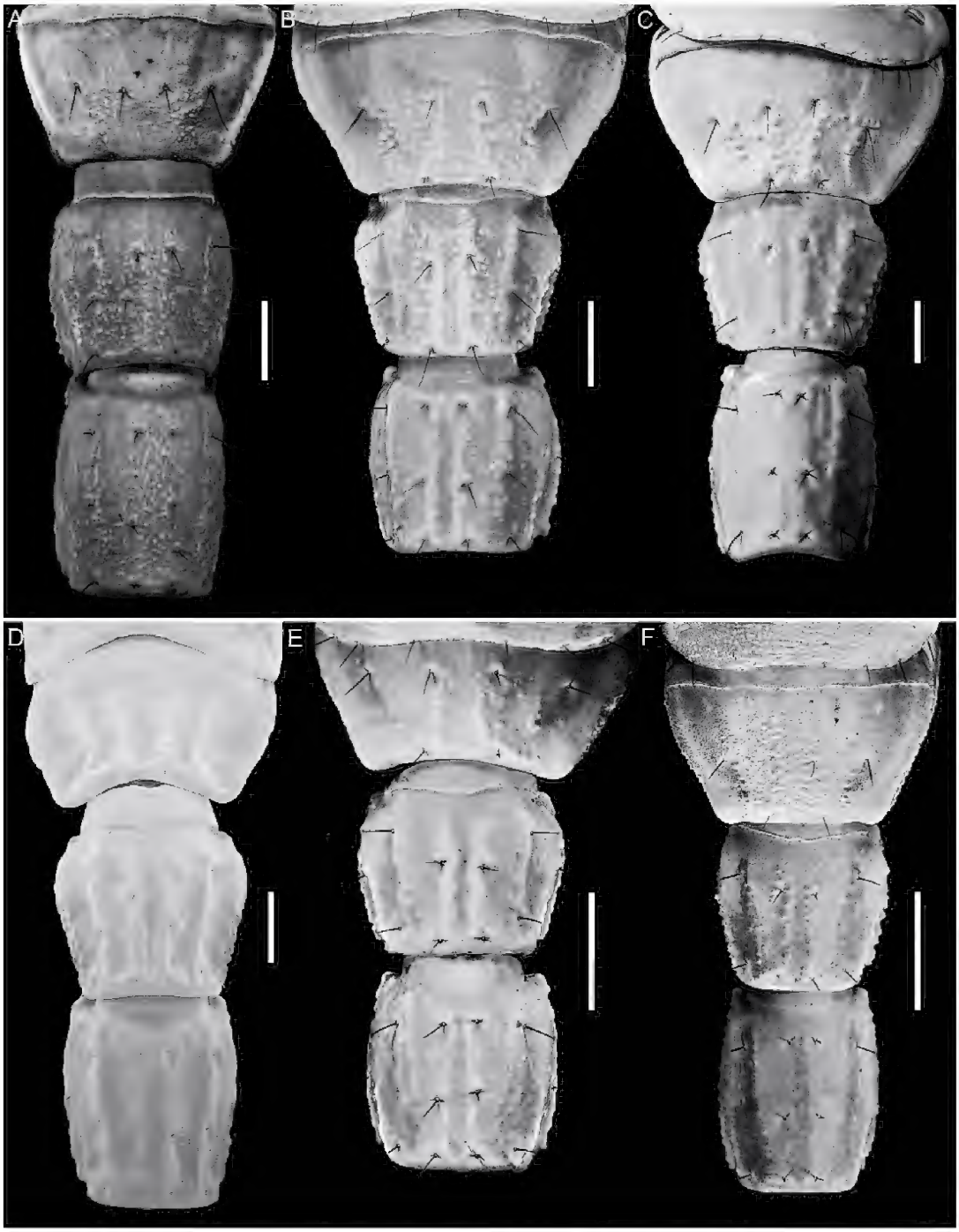

Fig. 18. *Orobothriurus* Maury, 1976, sternite VII and metasomal segments I and II, ventral aspect. **A.** *Orobothriurus atiquipa* Ochoa and Acosta, 2003, paratype ♂ (MHNC). **B.** *Orobothriurus calchaqui*, n. sp., paratype ♀ (MACN-Ar). **C.** *Orobothriurus ramirezi*, n. sp., paratype ♀ (MACN-Ar). **D.** *Orobothriurus alticola* (Pocock, 1899), ♀ (MACN-Ar). **E, F.** *Orobothriurus compagnuccii*, n. sp. **E.** Paratype ♀ (MACN-Ar). **F.** Paratype ♂ (MACN-Ar). Scale bars = 1 mm.

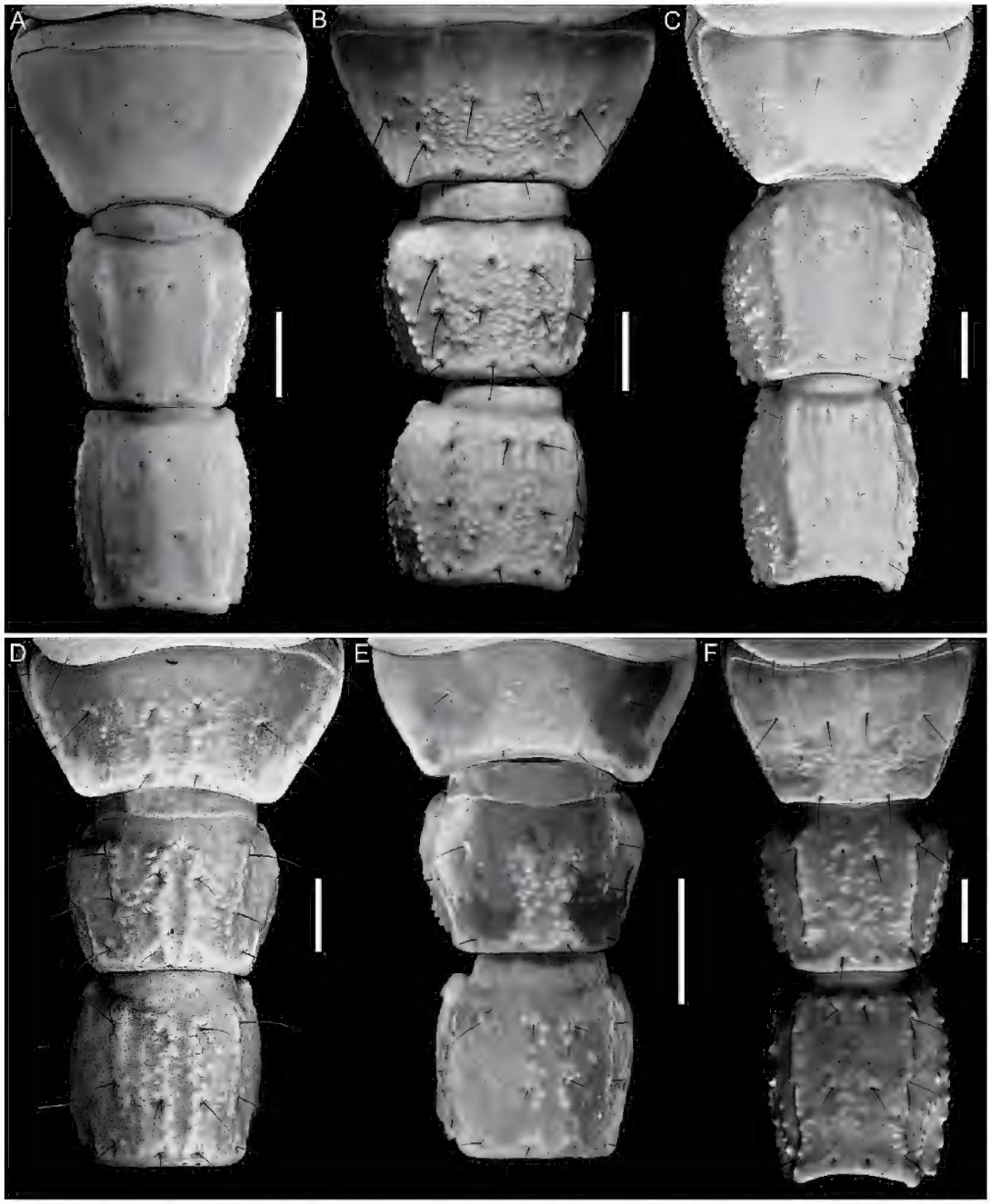

Fig. 19. *Orobothriurus* Maury, 1976, sternite VII and metasomal segments I and II, ventral aspect. **A.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♀ (MHNC). **B.** *Orobothriurus paessleri* (Kraepelin, 1911), ♀ (MHNC). **C.** *Orobothriurus quewerukana*, n. sp., paratype ♂ (MHNC). **D.** *Orobothriurus huascaran*, n. sp., paratype ♀ (MACN-Ar). **E.** *Orobothriurus wawita* Acosta and Ochoa, 2000, paratype ♀ (MHNC). **F.** *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar). Scale bars = 1 mm.

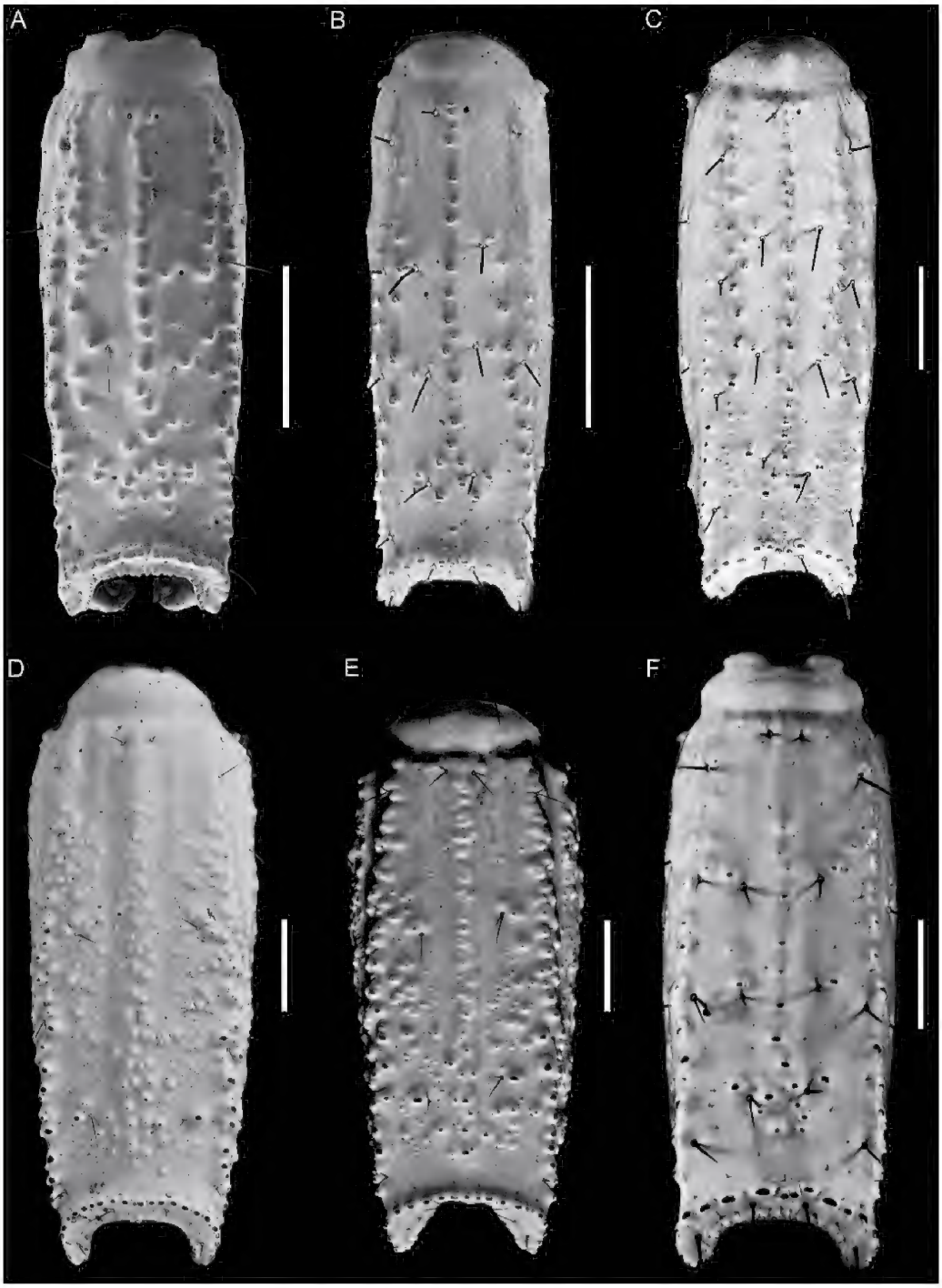

Fig. 20. *Orobothriurus* Maury, 1976, metasomal segment V, ventral aspect. **A.** *Orobothriurus alticola* (Pocock, 1899), ♀ (MACN-Ar). **B.** *Orobothriurus compagnuccii*, n. sp., paratype ♂ (MACN-Ar). **C.** *Orobothriurus ramirezi*, n. sp., paratype ♂ (MACN-Ar). **D.** *Orobothriurus quewerukana* , n. sp., paratype ♂ (MHNC). **E.** *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar). **F.** *O. ramirezi*, n. sp., paratype ♀ (MACN-Ar). Scale bars = 1 mm.

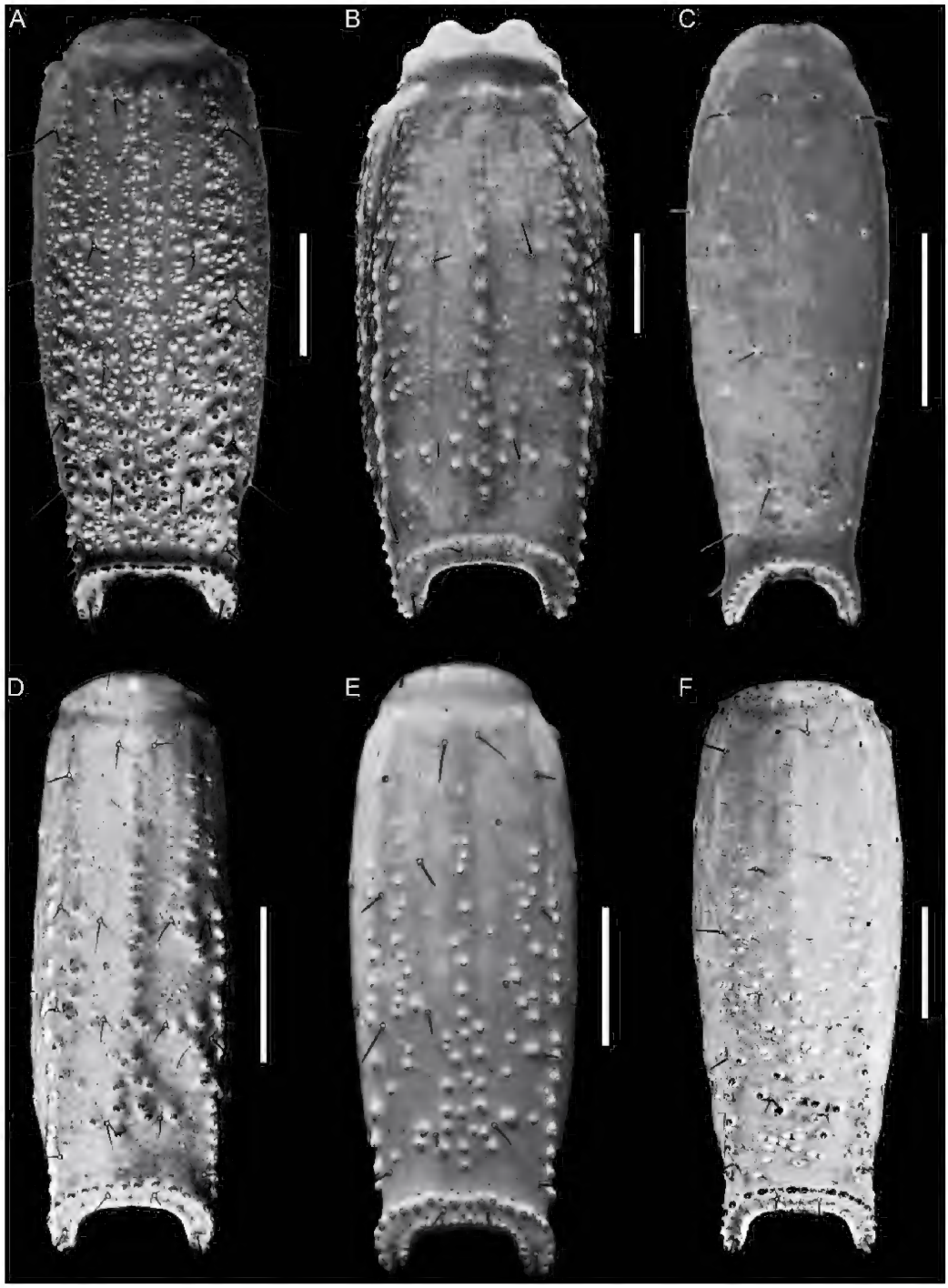

Fig. 21. *Orobothriurus* Maury, 1976, metasomal segment V, ventral aspect. **A.** *Orobothriurus atiquipa* Ochoa and Acosta, 2002, paratype ♂ (MHNC). **B.** *Orobothriurus paessleri* (Kraepelin, 1911), ♂ (MACN-Ar). **C.** *Orobothriurus wawita* Acosta and Ochoa, 2000, paratype ♂ (MHNC). **D.** *Orobothriurus calchaqui*, n. sp., paratype ♂ (MACN-Ar). **E.** *Orobothriurus grismadoi* Ojanguren Afillastro et al., 2009, paratype ♂ (MACN-Ar). **F.** *Orobothriurus huascaran*, n. sp., paratype ♂ (MACN-Ar). Scale bars = 1 mm.

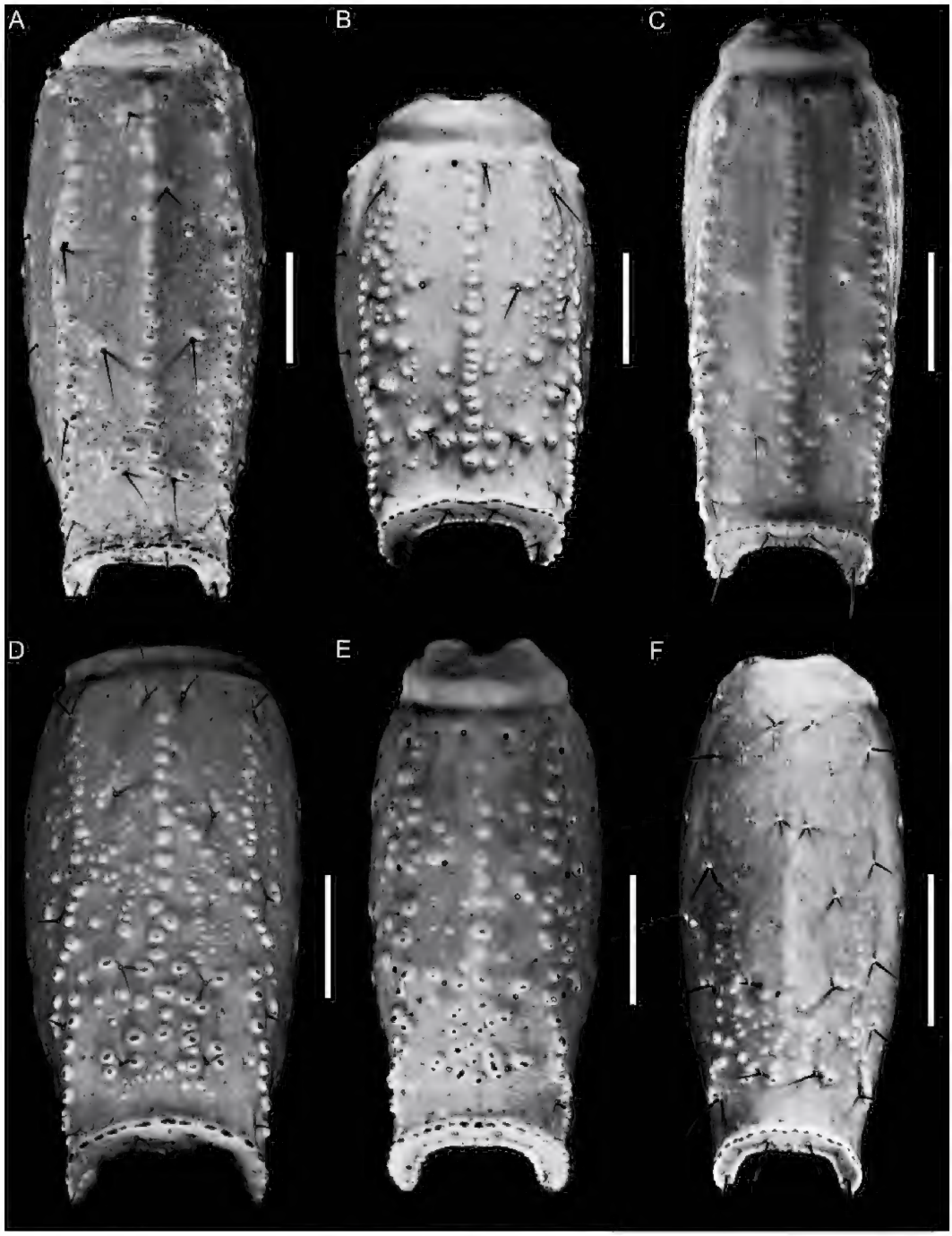

Fig. 22. *Orobothriurus* Maury, 1976, metasomal segment V, ventral aspect. **A.** *Orobothriurus ampay* Ochoa and Acosta, 2003, paratype ♀ (MHNC). **B.** *Orobothriurus paessleri* (Kraepelin, 1911), ♀ (MHNC). **C.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♀ (MHNC). **D.** *Orobothriurus huascaran*, n. sp., paratype ♀ (MACN-Ar). **E.** *Orobothriurus parvus* Maury, 1976, ♀ (MHNC). **F.** *Orobothriurus wawita* Acosta and Ochoa, 2000, paratype ♀ (MHNC). Scale bars = 1 mm.

sublaterally (fig. 29B, D). Metasomal segment I, dorsal surface unpigmented or with two small faint spots medially; lateral surfaces densely pigmented between ML and LIM carinae (fig. 29); ventral surface with two narrow VL stripes, becoming slightly broader in posterior half. Segment II, dorsal surface with two subtriangular spots medially; lateral surface as for segment I; ventral surface with one narrow VM and two narrow VL stripes, becoming slightly broader in posterior half. Segment III, dorsal surface as for segment II; lateral surfaces densely pigmented below ML carinae; ventral surface as for segment II. Segment IV, dorsal surface with reticulate pigmentation medially; lateral and ventral surfaces as for segment III. Segment V, dorsal and lateral surfaces as for segment IV; ventral surface with three dark narrow stripes (one VM and two VL), becoming slightly broader in posterior half but not contiguous with lateral pigmentation at posterior margin. Telson vesicle with narrow VM and two broad, dark VL stripes, separated by two narrow unpigmented stripes; aculeus sclerotized, dark reddish brown.

Chelicerae: Movable finger with two subdistal teeth.

Carapace: Surfaces smooth medially, finely granular near lateral margins. Anterior margin with shallow median notch (fig. 14A). Anteromedian longitudinal sulcus weakly developed; median ocular, posteromedian longitudinal and posterolateral sulci well developed. Median ocular tubercle raised, situated anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, DI and VI carinae complete, finely granular; DE carina complete, finely granular proximally (fig. 30A); internal surface finely and sparsely granular medially; ventral surface finely granular proximally; other surfaces smooth. Patella, DI and VI carinae complete, finely granular (fig. 30B–D); DPP carina finely granular; VPP carina vestigial, comprising two or three small granules proximally; internal surface with prominent granule adjacent to trichobothrium *i* near DI carina. Chela manus slender, fingers relatively elongated (fig. 31); length/width ratio: ♂, 3.97–4.51 (n = 10; mean = 4.17), ♀, 3.47–3.73 (n = 4, mean = 3.63); length/height ratio: ♂, 3.40–4.03 (n = 10; mean = 3.71), ♀, 3.07–3.31 (n = 4, mean = 3.18); D, DS, DMA, DI, and VM carinae obsolete; intercarinal surfaces smooth; internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (fig. 31A, D); fingers, dentate margins each with median denticle row and 4–5 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27 (fig. 30, 31). Patella trichobothrium em_2 situated proximal to em_1 in 80% of specimens (fig. 30C). Chela trichobothrium Et_3 situated proximal to *Est* (fig. 31C).

Tergites: Tergites I–VI, surfaces finely granular, becoming smooth posterolaterally. Tergite VII tetracarinate, paired DL carinae restricted to posterior two-thirds of segment, paired DSM carinae to posterior half; intercarinal surfaces coarsely granular, other surfaces finely granular.

Legs: Femur and patella, prolateral surfaces finely granular, retrolateral surfaces smooth. Femur, ventral carinae weakly developed; other carinae absent. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 18–21 (n = 21, mode = 18); ♀, 14 (n = 4, mode = 14).

Sternites: Sternites III–VI, surfaces smooth; spiracles small, narrow. Sternite VII, surface smooth; VSM and VL carinae well developed (♀, fig. 17B) or obsolete (♂).

Metasoma: Segment I, DL carinae complete, moderately granular; ML carinae complete, moderately granular in posterior two-thirds; one pair of ML macrosetae; LIM carinae complete, moderately granular in posterior half; VL and VSM carinae complete, well developed (especially in ♀), granular (fig. 17B); three pairs of VL and two pairs of VSM macrosetae. Segment II, DL carinae complete, granular; ML carinae complete, granular in posterior two-thirds; one pair of ML macrosetae; LIM carinae restricted to posterior third; VL and VSM carinae complete, well developed (♀) or obsolete (♂); three pairs of VL and VSM macrosetae. Segment III, DL carinae complete, granular; ML carinae complete, granular in posterior third; one pair of ML

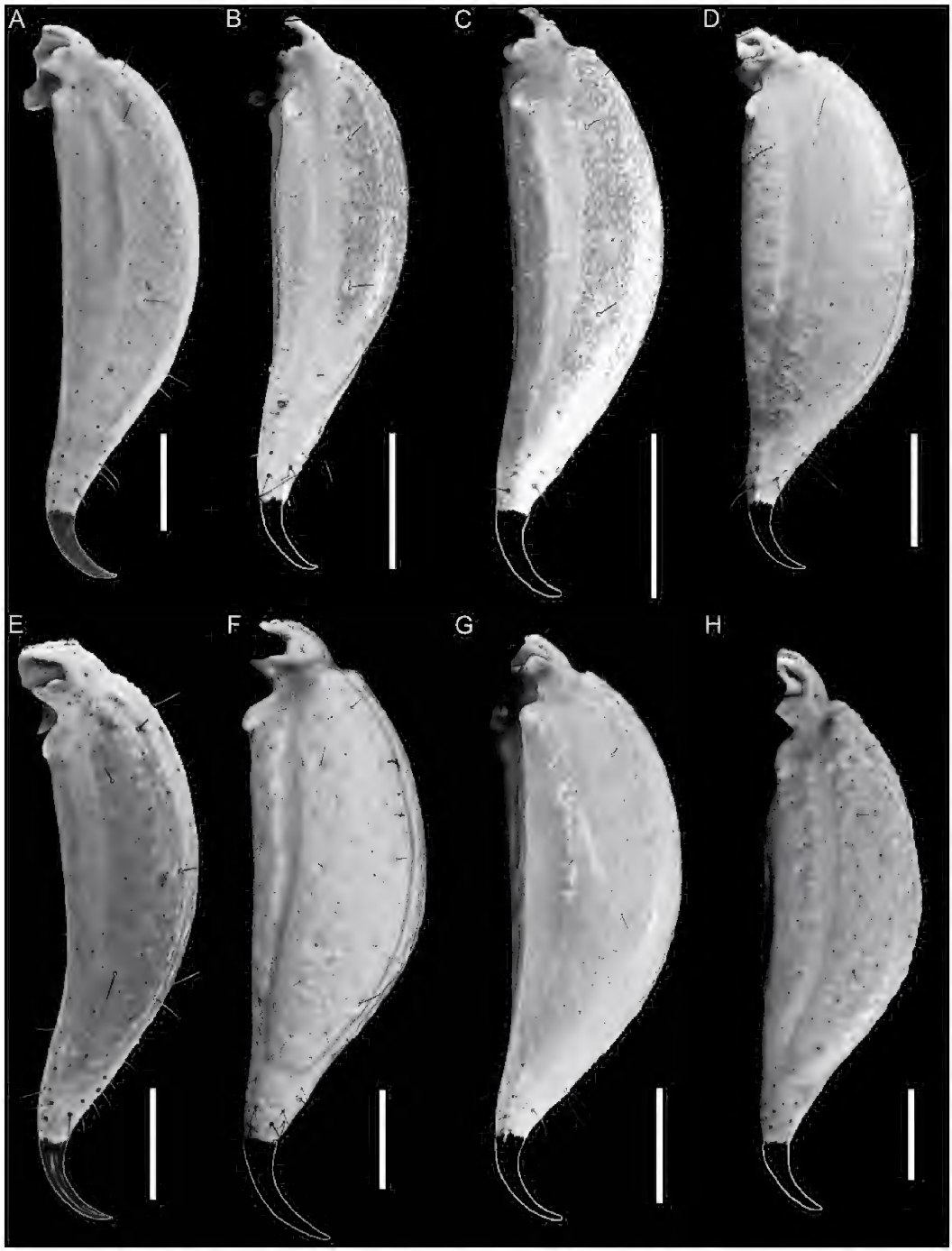

Fig. 23. *Orobothriurus* Maury, 1976, telson, lateral aspect. **A.** *Orobothriurus alticola* (Pocock, 1899), ♂ (MACN-Ar). **B.** *Orobothriurus calchaqui*, n. sp., paratype ♂ (MACN-Ar). **C.** *Orobothriurus compagnuccii*, n. sp., paratype ♂ (MACN-Ar). **D.** *Orobothriurus huascaran*, n. sp., paratype ♂ (MACN-Ar). **E.** *Orobothriurus grismadoi* Ojanguren Afillastro et al., 2009, paratype ♂ (MACN-Ar). **F.** *Orobothriurus quewerukana*, n. sp., paratype ♂ (MHNC). **G.** *Orobothriurus ramirezi*, n. sp., paratype ♂ (MACN-Ar). **H.** *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar). Scale bars = 1 mm.

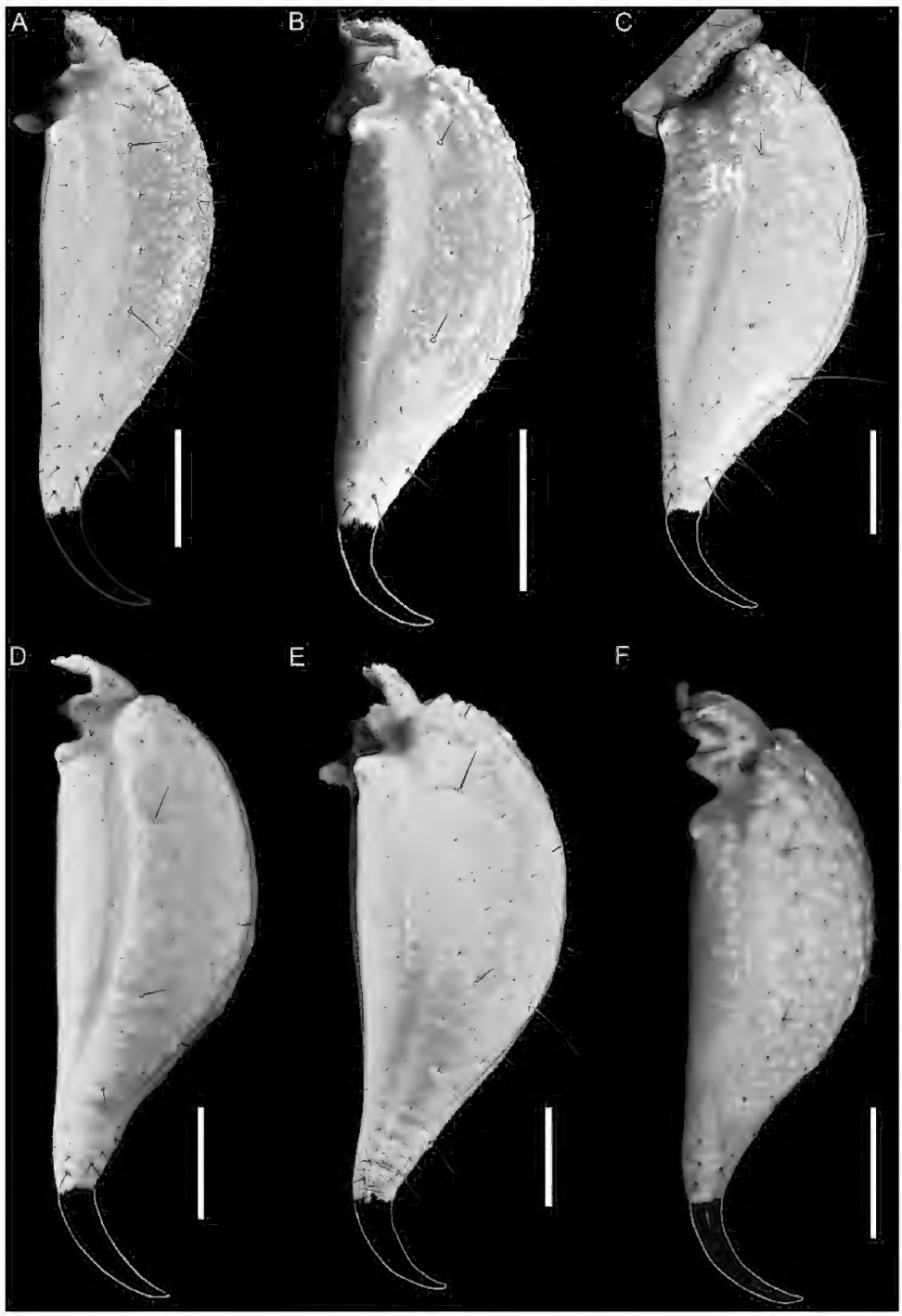

Fig. 24. *Orobothriurus* Maury, 1976, telson, lateral aspect. **A.** *Orobothriurus calchaqui*, n. sp., paratype ♀ (MACN-Ar). **B.** *Orobothriurus compagnuccii*, n. sp., paratype ♀ (MACN-Ar). **C.** *Orobothriurus huascaran*, n. sp., paratype ♀ (MACN-Ar). **D.** *Orobothriurus quewerukana*, n. sp., paratype ♀ (MHNC). **E.** *Orobothriurus ramirezi*, n. sp., paratype ♀ (MACN-Ar). **F.** *Orobothriurus tamarugal*, n. sp., paratype ♀ (MZUC). Scale bars = 1 mm.

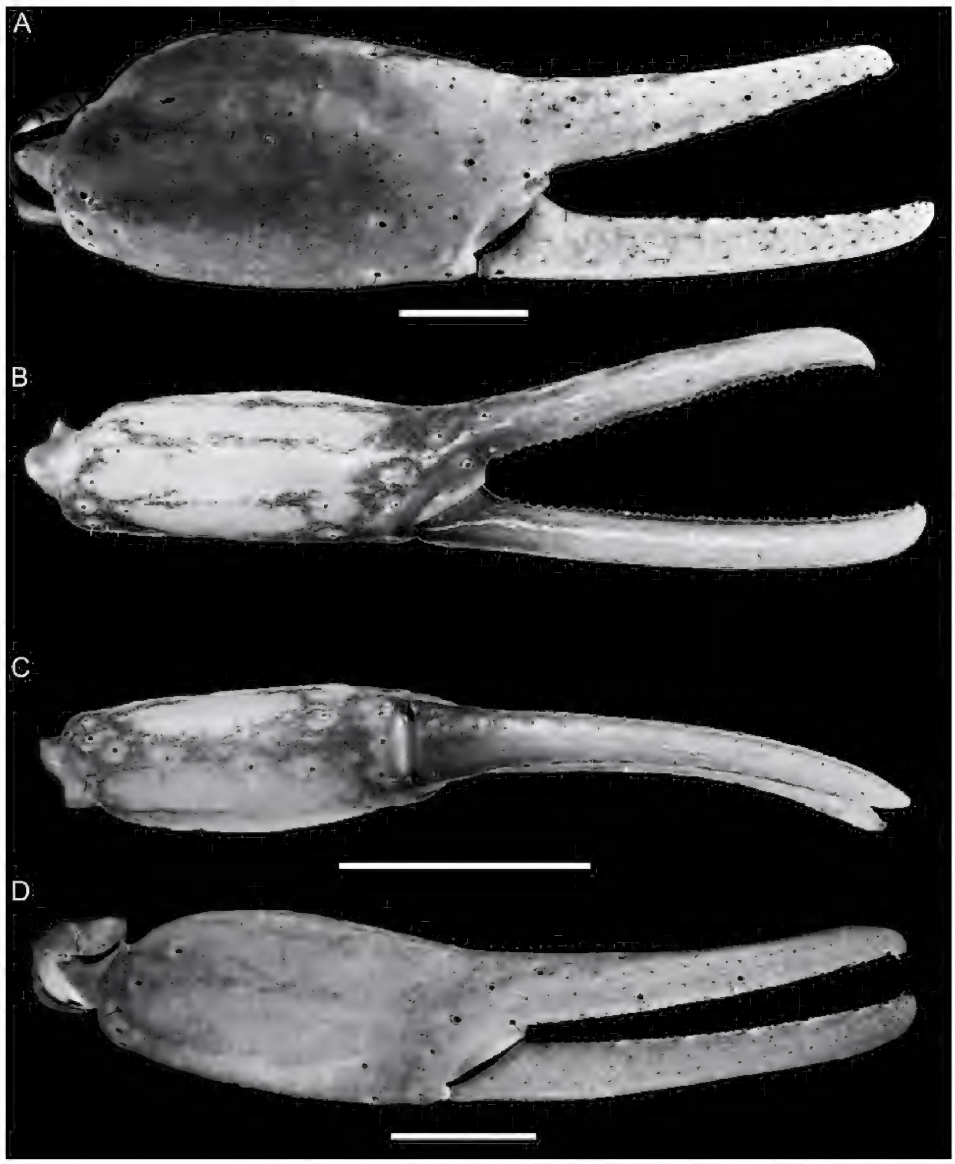

Fig. 25. *Orobothriurus* Maury, 1976, dextral pedipalp chela. **A.** *Orobothriurus ampay* Ochoa and Acosta, 2003, paratype ♀ (MHNC), external aspect. **B, C.** *Orobothriurus wawita* Acosta and Ochoa, 2000, paratype ♂ (MHNC). **B.** External aspect. **C.** Ventral aspect. **D.** *Orobothriurus atiquipa* Ochoa and Acosta, 2002, paratype ♂ (MHNC), external aspect Scale bars = 1 mm.

macrosetae; LIM carinae obsolete, restricted to posterior quarter; VL and VSM carinae complete, well developed (♀) or absent (♂); three pairs of VL and VSM macrosetae. Segment IV, DL carinae complete, granular; one pair of DL macrosetae; ML carinae obsolete, restricted to posterior margin; one pair of ML macrosetae; LIM carinae absent; VL and VSM carinae absent; three pairs of VL and VSM macrosetae. Segment V, length/width ratio, ♂, 2.33–2.73 (n = 10; mean = 2.52), ♀, 1.93–1.98 (n = 4; mean = 1.96); DL carinae granular, restricted to anterior half; ML carinae absent; four or five pairs of ML macrosetae; lateral margin smooth; VL carinae complete (♂) or restricted to posterior three-quarters (♀); VL and VSM carinae situated close together, fused in anterior and

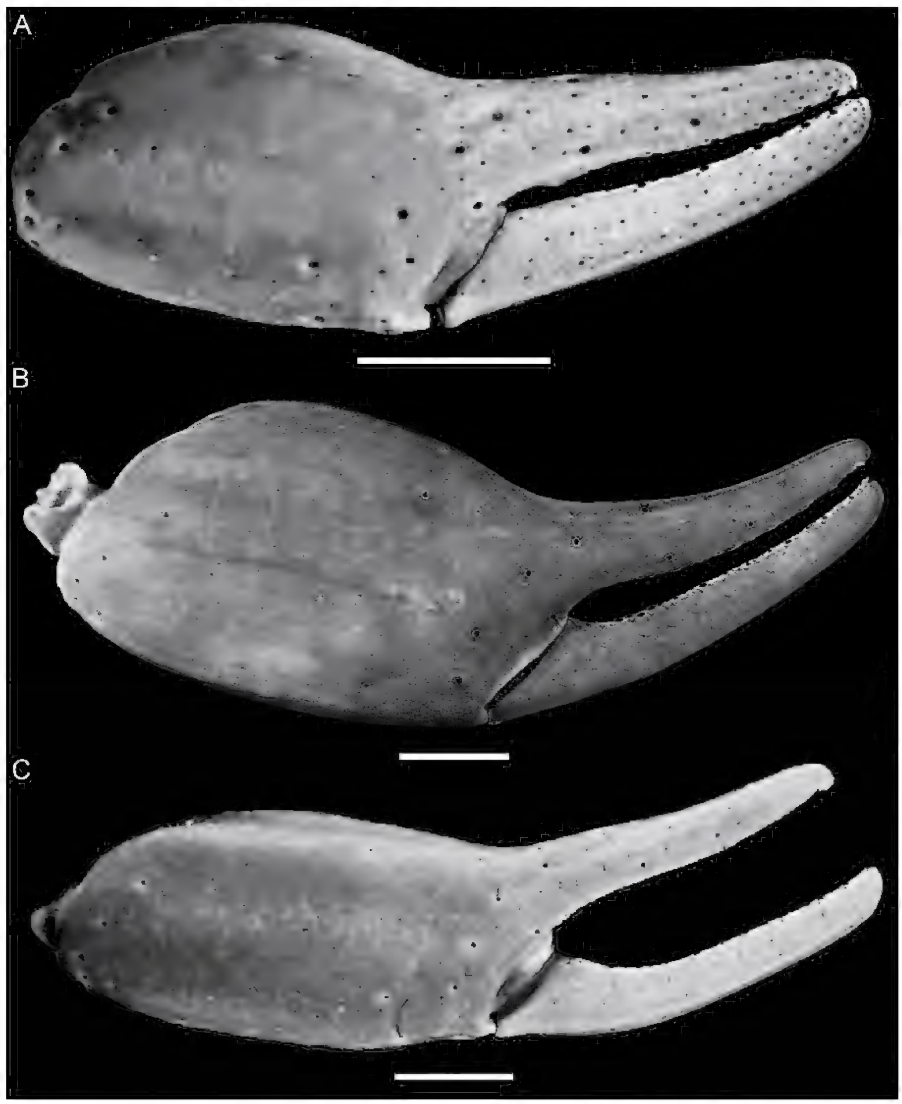

Fig. 26. *Orobothriurus* Maury, 1976, dextral pedipalp chela, external aspect. **A.** *Orobothriurus parvus* Maury, 1976, ♂ (MHNC). **B.** *Orobothriurus paessleri* (Kraepelin, 1911), ♂ (MACN-Ar). **C.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♂ (MHNC), external aspect. Scale bars = 1 mm.

posterior thirds; four pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin; VM carina complete, obscured by surface granulation in posterior half (fig. 21D).

Telson: Length/height ratio: ♂, 3.52–3.89 (n = 10, mean = 3.74); ♀, 2.93–3.13 (n = 4, mean = 3.01). Vesicle elongated (♂, fig. 23B) or globose (♀, fig. 24A); dorsal surface slightly concave, gland not apparent (♂); ventral surface smooth (♂) or granular (♀). Aculeus short and curved, more so in ♀.

Hemispermatophore: Apex very well developed; distal crest curved like ventral margin. Frontal crest weakly developed, less than half length of lamina; basal part oblique; distal part short, parallel to ventral margin of lamina; lateral projections slightly undulated. Basal lobe, terminal process extending almost to distal end of frontal crest (fig. 32A, B).

REMARKS: We examined some *Orobothriurus* specimens from other Andean localities in Salta and Tucumán provinces of northern Argentina. However, specimens from

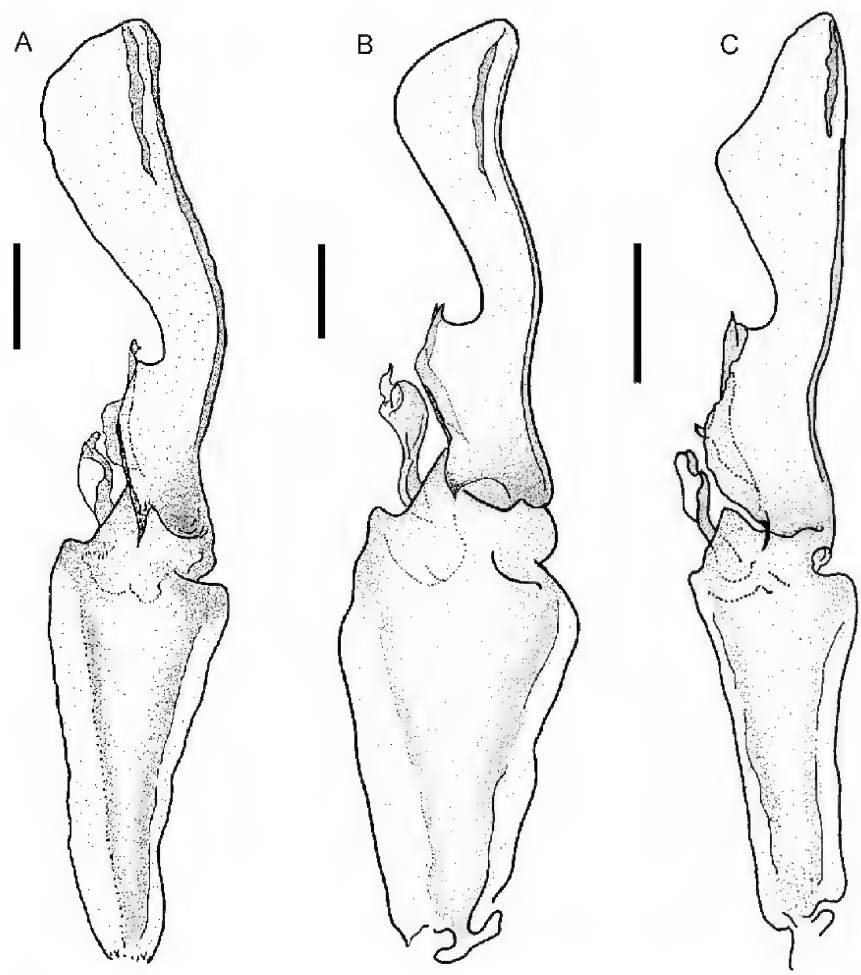

Fig. 27. *Orobothriurus* Maury, 1976, sinistral hemispermatophore, ectal aspect. **A.** *Orobothriurus ampay* Ochoa and Acosta, 2003, holotype ♂ (MUSM). **B.** *Orobothriurus parvus* Maury, 1976, ♂ (MHNC). **C.** *Orobothriurus wawita* Acosta and Ochoa, 2000, paratype ♂ (MHNC). Scale bar = 0.5 mm.

these localities are so scarce and the morphological differences between them and *O. calchaqui* so subtle that at this time it is unclear whether or not they are conspecific. More specimens from these *Orobothriurus* populations are required to establish their identity.

DISTRIBUTION: This species is known only from the type locality, Infiernillo Mountain (Tucumán Province, Argentina), belonging to the Cumbres Calchaquies, part of the Andes (fig. 54). Altitude records from Huaca Huasi (4250 m) and Vaca Huasi (4300 m) should be confirmed, because, at this latitude, the environment above 4000 m is usually too extreme for scorpions to survive.

ECOLOGY: All personally collected specimens were found at night in a rocky area near a small mountain river, at 2700 m. The area is a typical Puna habitat (Cabrera and Willink, 1980). Most specimens collected were on the ground, but some were taken from near-vertical rock walls besides the river, almost 2 m from its base. No specimens could be found in the surrounding area, which has a sandy soil without rocks. Most of the specimens collected were adult males, moving very rapidly, probably searching for females, suggesting that late November, the start of spring in the Southern Hemisphere, is the start of the active period for this species.

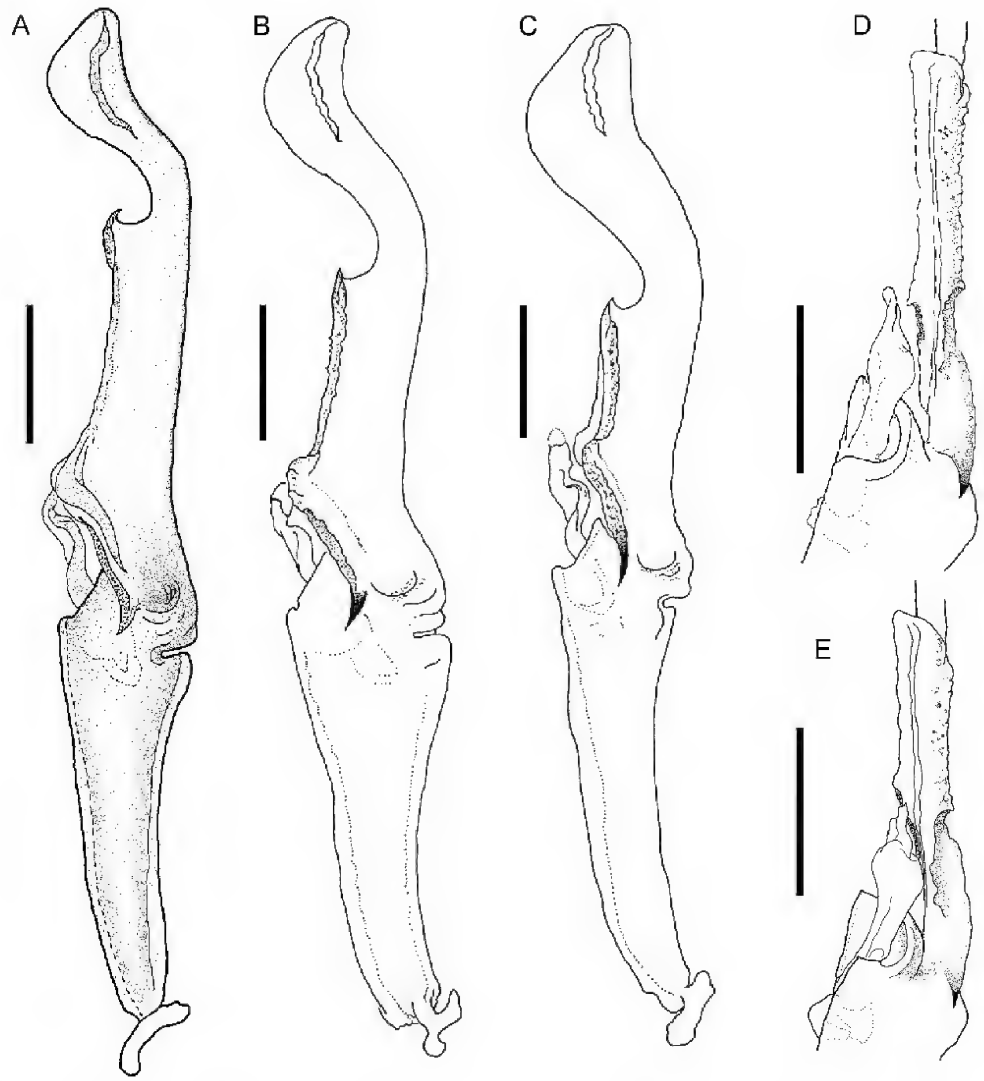

Fig. 28. *Orobothriurus* Maury, 1976, sinistral hemispermatophore. **A.** *Orobothriurus atiquipa* Ochoa and Acosta, 2002, holotype ♂ (MACN-Ar), ectal aspect. **B, D.** *Orobothriurus curvidigitus* (Kraepelin, 1911), ♂ (MHNC). **C, E.** *Orobothriurus paessleri* (Kraepelin, 1911), ♂ (MHNC). **B, C.** Ectal aspect. **D, E.** Frontal crest and lobe region, dorsal aspect. Scale bar = 1 mm.

No other scorpion species were collected in sympatry with *O. calchaqui*. However, another bothriurid, *Brachistosternus intermedius* Lönnberg, 1902, has been recorded in the vicinity (Ojanguren Affilastro, 2005).

Orobothriurus compagnuccii, n. sp.
Figures 14B, 18E, F, 20B, 21C, 24B, 32C, D, 33–35, 36A–C, 54; table 3

TYPE MATERIAL: **ARGENTINA: La Rioja Province:** *General Lamadrid Department*: Holotype ♂ (MACN-Ar), Laguna Brava Provincial Park, road to Laguna Brava, El Peñón refuge, 28°32′18.6″S 68°45′11.9″W, 3200 m, i.2003, A. Ojanguren Affilastro and P. Korob (MACN-Ar). Paratypes: Laguna Brava Provincial Park, road to Laguna Brava, 28°27′17.2″S 68°50′39.9″W, 3835 m, 4.iii.2002, A. Ojanguren Affilastro and P. Korob, 2 ♀ (MACN-Ar), 28°30′26.5″S 68′47′57.0″W, 3600 m, 23.i.2007, A. Ojanguren Affilastro, L. Compagnucci, and J.J. Martínez, 2 ♂ (MACN-Ar), 28°25′54.1″S 68°50′34.7″W,

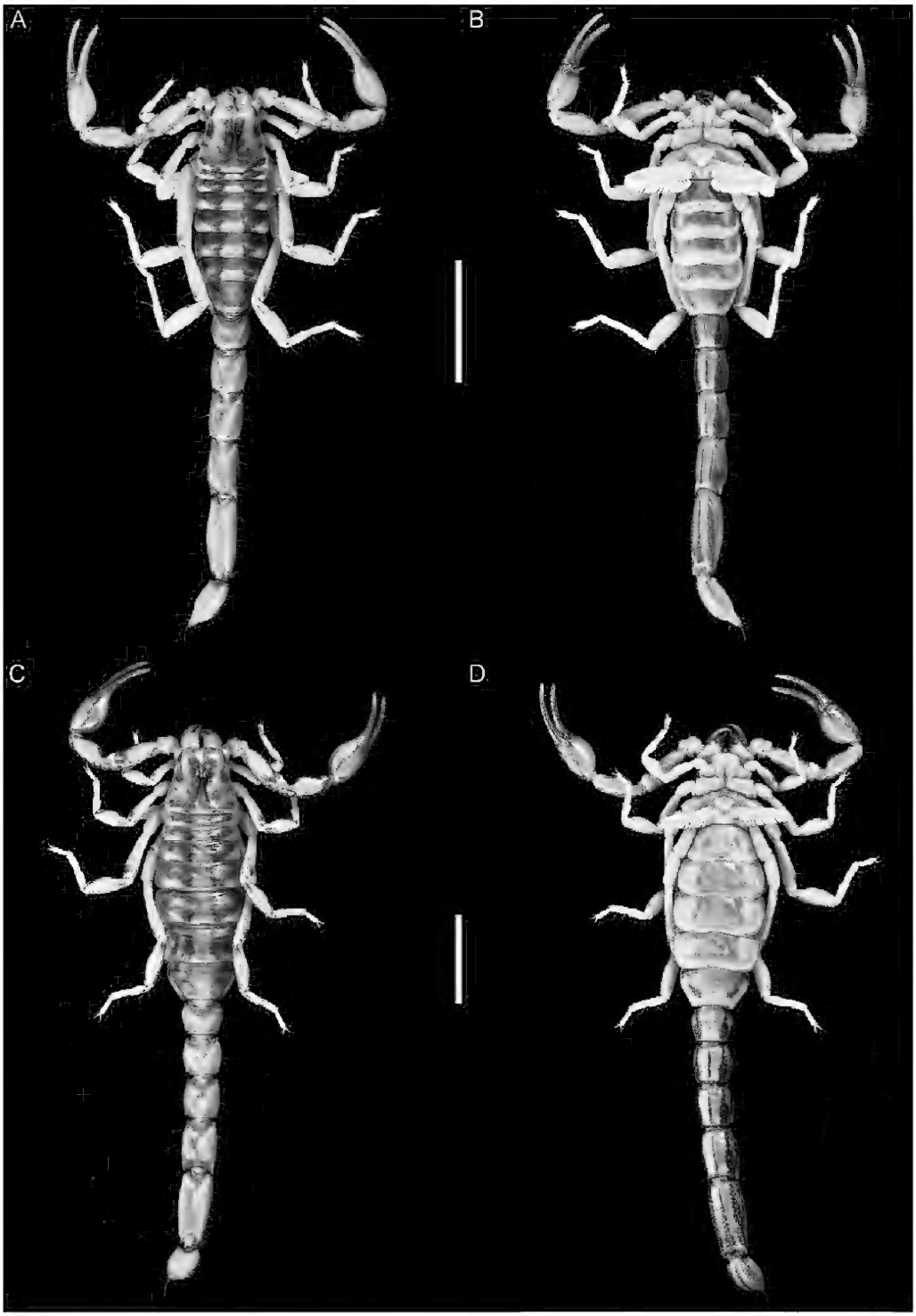

Fig. 29. *Orobothriurus calchaqui*, n. sp., habitus. **A, B.** Paratype ♂ (MACN-Ar). **C, D.** Paratype ♀ (MACN-Ar). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 5 mm.

3900 m, 27.i.2006, A. Ojanguren Affilastro, L. Compagnucci, and L. Piacentini, 2 ♀ (MACN-Ar), 28°25′50.3″S 68°50′31.3″W, 3900 m, 27.i.2006, A. Ojanguren Affilastro, L. Compagnucci, and L. Piacentini, 1 juv. ♂ (AMNH [LP 5847]).

ETYMOLOGY: This species is named after Argentine entomologist Luis Compagnucci (MACN), who participated in several expeditions and collected part of the type material of this species.

DIAGNOSIS: *Orobothriurus compagnuccii* is similar to *O. calchaqui* and *O. famatina*. The three species can be separated by the shape of the lamina of the hemispermatophore, which has a more developed apex in *O. calchaqui* and *O. famatina*: the apex comprises 52.17%–54.54% (n = 3; mean = 52.98%) of the lamina in *O. compagnuccii* (fig. 36A–C), 66.6%–68.48% (n = 3, mean = 67.02%) in *O. famatina* (fig. 36F–H), and 69.0%–71.56% (n = 6; mean = 70.43%) in *O. calchaqui* (fig. 36K–O). *Orobothriurus compagnuccii* can be separated from *O. alticola* and *O. grismadoi* by means of the same characters: the apex comprises 40.87%%–46.08% (n = 20; mean = 43.88%) of the lamina in *O. alticola* and 42.70–45.69% (n = 7; mean = 44.17%) in *O. grismadoi*. *Orobothriurus compagnuccii* can be distinguished from other Argentine species of the genus, in which the VL and VSM carinae of sternite VII and metasomal segment I are well developed (fig. 18B, D), by the weak development or absence of these carinae, which are less developed in males (fig. 18E, F).

DESCRIPTION: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 23.91–25.6 mm (n = 3, mean = 24.86 mm); ♀, 24.5–30 mm (n = 4, mean = 27.75 mm).

Color: General color yellowish with dark brown spots. Carapace, anterior margin faintly pigmented (fig. 33A, C); lateral margins with two large spots medially and posteriorly, intermediate area with reticulate pigmentation; lateral margins with two large spots laterally and posterolaterally, remaining area with reticulate pigmentation; median ocular tubercle and lateral ocelli dark brown to black; posterior half of anteromedian longitudinal sulcus, median ocular tubercle, and anterior half of postocular furrow pigmented. Chelicerae, distal margin of movable finger with reticulate pigmentation. Pedipalp femur and patella, dorsal margin densely pigmented; chela manus with seven complete longitudinal stripes along carinae, contiguous at base of movable finger; fingers and articulation of fingers pigmented. Legs, especially femur, with reticulate pigmentation near articulations and along dorsal margins. Tergites I–VI each with two dark spots sublaterally along almost entire margin and pretergites, broader near anterior margin, delimiting broad, unpigmented median stripe (fig. 33A, C); VII with four dark spots, two spots posterolaterally, occupying area between dorsolateral carinae and external margins of sclerite, and two small dark triangular spots submedially, extending along submedian carinae, delimiting unpigmented median stripe. Sternum, genital opercula, and pectines unpigmented. Sternites III–VI usually unpigmented, but lateral margins of segments V and VI faintly pigmented in some specimens; VII with two dark narrow stripes sublaterally (fig. 33B, D). Metasomal segment I, dorsal surface with two small, faint spots medially, separated by narrow unpigmented median stripe; lateral surfaces densely pigmented between ML and LIM carinae (fig. 33B, D); ventral surface with three narrow stripes, two VL and one VM, becoming slightly broader, but not contiguous, in posterior half. Segment II similar to segment I, but with dorsal spots joining in some specimens. Segments III and IV similar to segment I but with dorsal spots contiguous, and DL carinae faintly pigmented. Segment V, dorsal surface with two dark stripes, contiguous in posterior third, faint or absent in some specimens; lateral surfaces each with faint narrow stripe in anterior half; ventral surface as for segments I–IV. Telson vesicle with three broad dark stripes (one VM and two VL), separated by two narrow unpigmented stripes; dorsal surface slightly pigmented on lateral margins; aculeus sclerotized, dark reddish brown.

Chelicerae: Movable finger with two subdistal teeth.

Carapace: Surfaces finely granular (♂) or smooth (♀). Anterior margin sublinear, with very shallow median notch (fig. 14B), more

developed in ♀. Anteromedian longitudinal sulcus incomplete, absent at anterior margin and weakly developed toward median ocular tubercle; median ocular sulcus well developed; posteromedian longitudinal and posterolateral sulci obsolete (fig. 14B). Median ocular tubercle shallow, situated anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, DI and VI carinae complete, granular; DE carina granular, restricted to proximal three-quarters of segment (fig. 34A); internal surface finely and sparsely granular. Patella, DI and VI carinae complete, granular (♂) or obsolete (♀) (fig. 34B–D); DPP comprising small granules proximally; VPP vestigial, reduced to one or two small granules medially (♂) or absent (♀); internal surface with prominent granule adjacent to trichobothrium *i* near DI carina; other intercarinal surfaces smooth. Chela manus slender, fingers relatively elongated (fig. 35); length/width ratio: ♂, 3.81–4.47 (n = 3, mean = 4.17), ♀, 3.75–4.19 (n = 4, mean = 3.97); length/height ratio: ♂, 3.31–3.47 (n = 3, mean = 3.39), ♀, 3.17–3.40 (n = 4, mean = 3.26); DMA, DI, and VM carinae obsolete; intercarinal surfaces smooth; internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (fig. 35A, D); fingers, dentate margins each with median denticle row and 4–5 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27 (fig. 34, 35). Chela trichobothrium Et_3 situated in same axis as, or slightly proximal to *Est* (fig. 35C).

Tergites: Tergites I–VI, surfaces smooth (♀) or finely granular (♂), more coarsely so near lateral margins. Tergite VII tetracarinate, paired DL carinae restricted to posterior two-thirds of segment, paired DSM carinae to posterior third; intercarinal surfaces coarsely granular, other surfaces finely granular.

Legs: Femur and patella, prolateral surfaces finely granular (♂), retrolateral surfaces smooth. Femur, ventral carinae weakly developed; other carinae absent. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 21–23 (n = 3); ♀, 16–18 (n = 4, mode = 17).

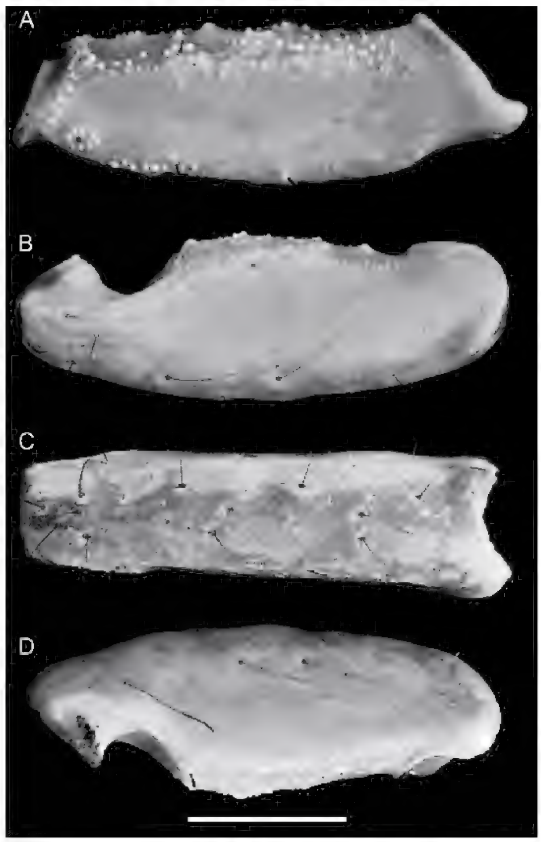

Fig. 30. *Orobothriurus calchaqui*, n. sp., paratype ♂ (MACN-Ar), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

Sternites: Sternites III–VI, surfaces smooth (♀) or densely granular medially (♂); spiracles small, narrow. Sternite VII, surface with six ventral macrosetae, smooth in anterior half, densely granular in posterior half (♂); VL and VSM carinae obsolete (indistinct from granulation) or absent (fig. 18E, F).

Metasoma: Segment I, DL and ML carinae complete, moderately granular; one pair of ML macrosetae; LIM carinae restricted to posterior two-thirds, moderately granular; VL and VSM carinae complete but indistinct, sparsely and finely (♂) or coarsely (♀) granular (fig. 18E, F); two pairs of VL and VSM macrosetae. Segment II, DL and ML carinae complete, granular; one pair of DL and ML macrosetae (DL macrosetae absent in some specimens); LIM carinae restricted to posterior quarter; VL and VSM carinae

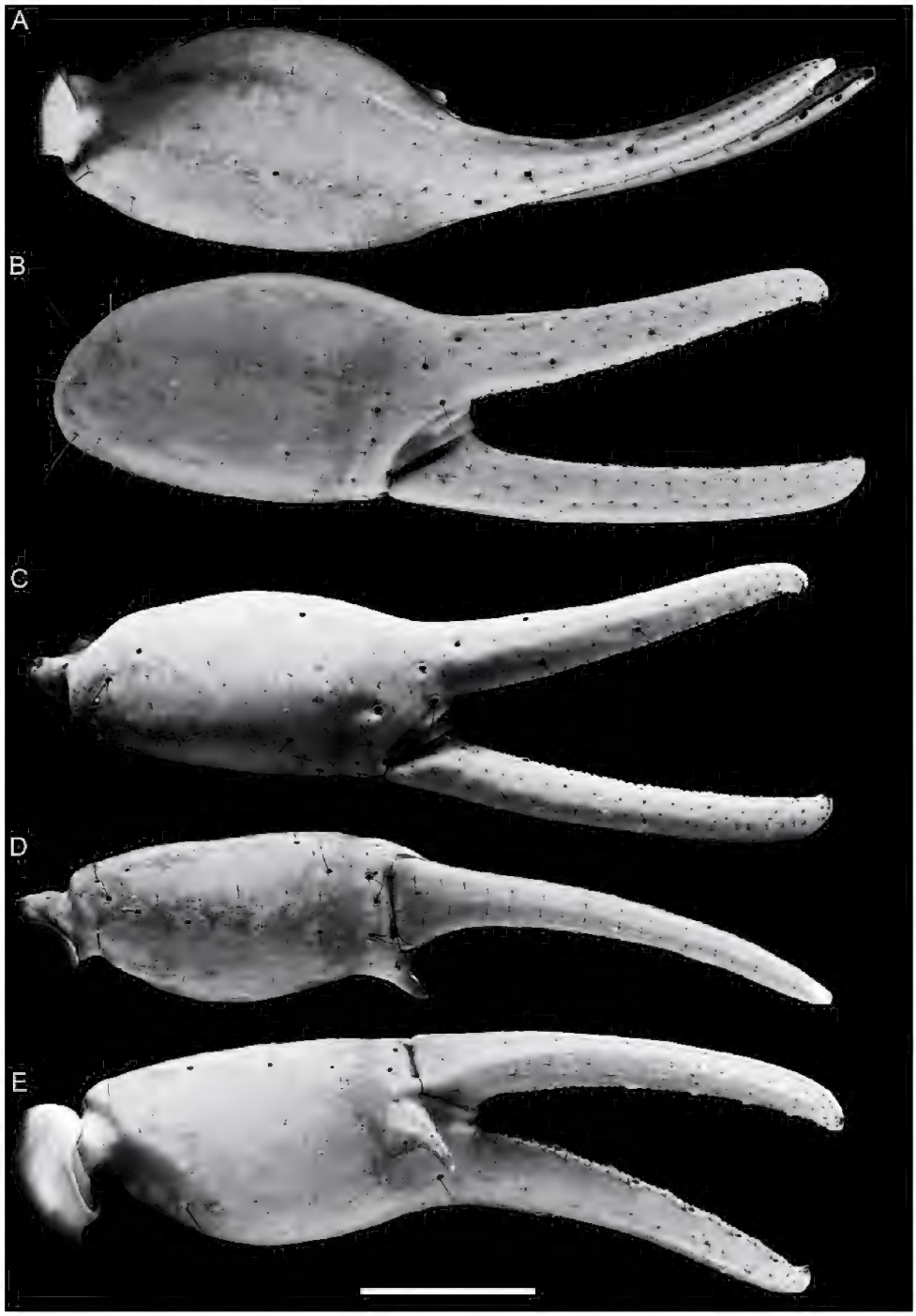

Fig. 31. *Orobothriurus calchaqui*, n. sp., dextral pedipalp chela. **A, B**. Paratype ♀ (MACN-Ar). **A.** Dorsal aspect. **B.** External aspect. **C–E.** Paratype ♂ (MACN-Ar). **C.** External aspect. **D.** Ventral aspect. **E.** Ventrointernal aspect. Scale bars = 1 mm.

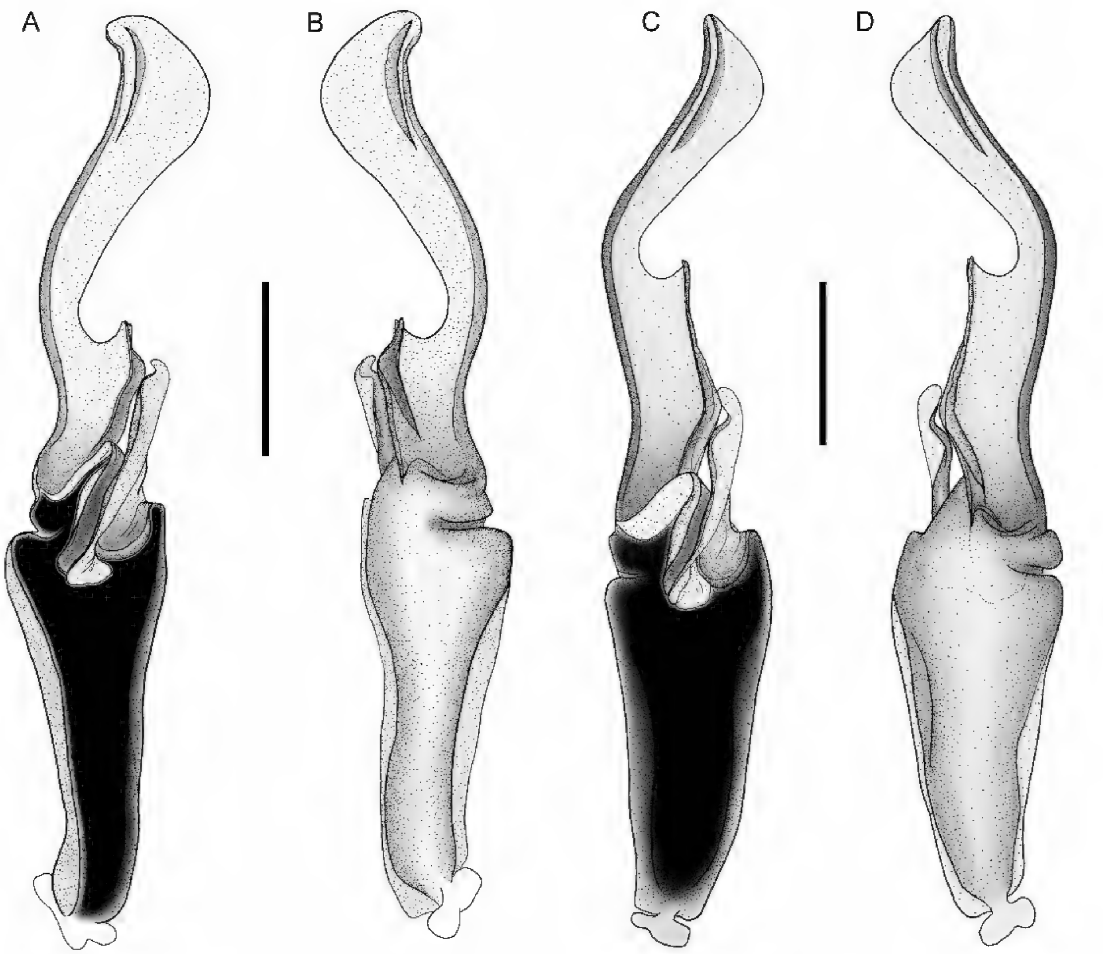

Fig. 32. *Orobothriurus* Maury, 1976, sinistral hemispermatophores. **A, B.** *Orobothriurus calchaqui*, n. sp., paratype ♂ (MACN-Ar). **C, D.** *Orobothriurus compagnuccii*, n. sp., paratype ♂ (MACN-Ar). **A, C.** Ental aspect. **B, D.** Ectal aspect. Scale bar = 1 mm.

absent (♂, some ♀) or obsolete (some ♀); two pairs of VL and three pairs of VSM macrosetae (fig. 18E, F). Segment III as for segment II, but ventral intercarinal surfaces smooth and carinae less developed. Segment IV, DL carinae complete, granular; one pair of DL macrosetae; ML carinae obsolete, restricted to posterior margin; one pair of ML macrosetae; LIM carinae absent; VSM and VL carinae absent; three pairs of VSM and VL macrosetae. Segment V, length/width ratio: ♂, 2.92–3.17 (n = 3, mean = 3.10), ♀, 2.03–2.14, (n = 4, mean = 2.09); DL carinae granular, complete (♀) or restricted to anterior half (♂); DL macrosetae absent; ML carinae absent; four pairs of ML macrosetae; lateral margin smooth; VL carinae complete (♂) or restricted to posterior three-quarters (♀); VL and VSM carinae situated close together, fused in anterior and posterior thirds; four pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin; VM carina complete, obscured by surface granulation in posterior half (fig. 20B).

Telson: Length/height ratio: ♂, 3.57–4.12 (n = 3, mean = 3.76); ♀, 2.81–2.97 (n = 4, mean = 2.90). Vesicle elongated (♂, fig. 23C) or globose (♀, fig. 24B); dorsal surface flat, gland not apparent (♂); ventral surface smooth (♂) or granular (♀). Aculeus short and curved, more so in ♀.

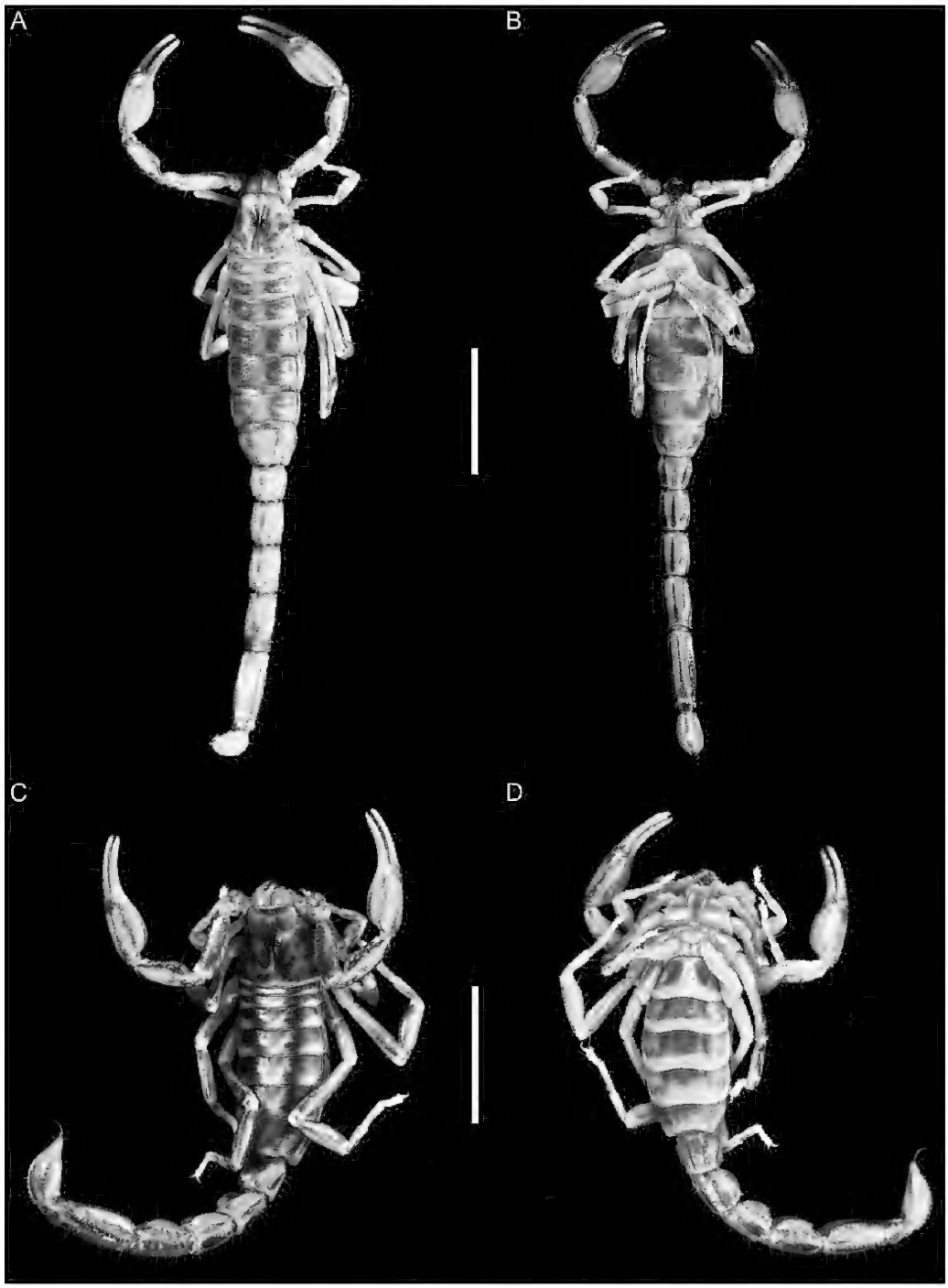

Fig. 33. *Orobothriurus compagnuccii*, n. sp., habitus. **A, B.** Paratype ♂ (MACN-Ar). **C, D.** Paratype ♀ (MACN-Ar). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 5 mm.

Hemispermatophore: Apex well developed, slightly longer than frontal crest, comprising 52.17–54.54% (n = 3; mean = 52.98%) of lamina; distal crest curved like ventral margin. Frontal crest divided into two parts, basal part oblique, distal part parallel to ventral margin of lamina; lateral projections slightly undulated and larger than basal part. Basal lobe, terminal process extending to median part of frontal crest (fig. 32C, D).

DISTRIBUTION: *Orobothriurus compagnuccii* is known only from the type locality, Laguna Brava Provincial Park, in the western Andres of La Rioja Province, northwestern Argentina (fig. 54). All specimens were collected on the ascent to Pircas Negras international pass, on the border between Argentina and Chile, at 3200–3900 m.

ECOLOGY: The habitat at the type locality is intermediate between Puna and high Andean habitats (Cabrera and Willink, 1980), with very sparse vegetation. All specimens were collected in areas with very pronounced slopes, on high rocks or spiny shrubs. We conducted several expeditions to the type locality of this species, in different years and at different times during the summer, when *Orobothriurus* are presumed to be most active at this latitude. However, despite considerable effort, only a few specimens were collected each time. Most were very difficult to find, hiding in inaccessible places, e.g., in vertical rocks more than two or three meters above ground level. In the same area, we collected many *Brachistosternus montanus*, a bothriurid species more than twice the size of *O. compagnuccii*. The scarcity of *O. compagnuccii* during summer expeditions, and its habitat preference for places inaccessible to larger scorpions adapted to sandy soils like *Brachistosternus*, may be explained by the abundance of *B. montanus*. It is possible that the active period of *O. compagnuccii* starts in early spring, before that of *B. montanus*, to avoid competition and predation by the larger species.

Orobothriurus curvidigitus (Kraepelin, 1911)
Figures 11B, 12C, 13E, 14C, 19A, 22C, 26C, 28B, D, 53

Bothriurus curvidigitus Kraepelin, 1911: 91, 97–99, fig. 7a, 7b; Mello-Leitão, 1931: 82, 92; 1932: 34; 1934: 65; 1935: 93; 1937: 103; 1945: 161; Aguilar and Meneses, 1970: 2; Maury, 1973: 110; 1981: 104.

Bothriurus lampei Werner, 1916: 92 [synonymized by Maury, 1973: 110]; Lampe, 1917: 203; Mello-Leitão, 1931: 88; 1932: 34; 1945: 175; Aguilar and Meneses, 1970: 2; Maury, 1973: 110; 1981: 104.

Bothriurus (*Andibothriurus*) *curvidigitus*: Bücherl et al., 1963: 216.

Bothriurus (*Andibothriurus*) *lampei*: Francke, 1974: 219.

Orobothriurus curvidigitus: Maury, 1976: 18, 19, figs. 11–24, table I; 1980: 338; 1981: 101; Francke, 1977: 75; Kovařík, 1998: 101; Acosta and Ochoa, 2000: 136, 143; Lowe and Fet, 2000: 35, 36; Acosta and Ochoa, 2001: 205; Ochoa and Acosta, 2002a: 102, fig. 9; Ochoa, 2004a: 52, 55, 73, figs. 1, 2, 13, 19, 21, table 1; 2005: 55, figs. 7, 10, table 2.

Fig. 34. *Orobothriurus compagnuccii*, n. sp., paratype ♂ (MACN-Ar), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

TYPE MATERIAL: **PERU: Arequipa Department:** *Arequipa Province*: 1 ♂, 1 subad.

Fig. 35. *Orobothriurus compagnuccii*, n. sp., dextral pedipalp chela. **A, B.** Paratype ♀ (MACN-Ar). **C–E.** Paratype ♂ (MACN-Ar). **A.** Dorsal aspect. **B, C.** External aspect. **D.** Ventral aspect. **E.** Ventrointernal aspect. Scale bars = 1 mm.

♀ syntypes (ZMH), Yura [16°12′53″S 71°42′33″W, 2642 m], 20.vi.1909.

New Records: **PERU: Arequipa Department:** *Arequipa Province*: Agua del Milagro, Characato [16°28′S 71°28′W, 2460 m], 12.x.1983, E. Maury, 4 ♀, 8 juv. (MACN-Ar); Arequipa, 1937, P. Crawford, 1 ♀ (MACN-Ar); Canchimayo, Chiguata [16°24′13″S 71°23′34″W, 2950 m], 18.x.1998, J.A. Ochoa, 4 juv. (MHNC); Charcani, Arequipa, 2800 m, xi.1947, W. Weyrauch, 3 ♀, 2 juv. (MACN-Ar); entrance to Charcani Quinto, near Arequipa city, Chili (Radio Azul) [16°19′33″S 71°31′47″W, 2550 m], 28.ii.1998, E. Ponce and J.A. Ochoa, 1 juv. (MHNC); Espíritu Santo, Chiguata [16°24′28″S 71°23′07″W, 2900 m], 7.iii.1998, E. Ponce and J.A. Ochoa, 2 ♀, 1 juv. (MHNC); Miraflores, near Chiguata [16°23′S 71°21′W, 3295 m], 7.iii.1998, E. Ponce and J.A. Ochoa, 12 ♀, 3 juv. (MHNC), 3 ♀ (CDA 166); near Mollebaya river [16°28′56″S 71°28′01″W, 2513 m], 3.iii.1998, E. Ponce, D. Muñiz and J.A. Ochoa, 2 ♂, 6 ♀, 2 juv. (MHNC), 1 ♂, 1 ♀ (CDA 167); Ribera del Rio Mollebaya [ca. 16°28′56″S 71°28′01″W, 2513 m], 8.ii.2004, R. Cardeñas and J.A. Ochoa, 2 juv. (AMNH [LP 3064]); Socabaya [16°28′01″S 71°31′18″W, 2300 m], 1948, W. Weyrauch, 1 ♂ (MUSM), 2329 m, 5.ix.1998, U. Zanabria, 1 ♀ (MHNC); Yura [16°12′53″S 71°42′33″W, 2642 m], 7.viii.1939, K.P. Schmidt, 2 ♂, 1 juv. (FMNH), 8.viii.1939, K.P. Schmidt, 1 ♂, 1 ♀ (FMNH), 10.viii.1939, K.P. Schmidt, 1 ♂, 1 juv. (AMNH), 9.v.1998, U. Zanabria, 1 ♀, 2 juv. (MHNC); Yura, Río Yura, 20 m del Cementerio, 16°13′59″S 71°42′27″W, 2426 m, 29.xii.2007, R. Gutiérrez, A. Quiroz and J.A. Ochoa, Serrania Esteparia, collected at night with UV light, 3 juv. (AMNH [LP 8357]). *Cailloma Province*: Calera Chivay [15°38′34″S 71°36′01″W, 3640 m], 27.ix.1998, S. Rivera, 1 ♀ (MHNC); Curiña, Yanque [15°39′34″S 71°42′15″W, 3390 m], 20.xii.1996, J.A. Ochoa, 10 ♂, 3 juv. (MHNC); Curiña [3600 m], 21.xii.1996, J.A. Ochoa, 2 ♀, 4 juv. (MHNC).

Diagnosis: *Orobothriurus curvidigitus* is most closely related to *O. paessleri*, *O. quewerukana*, and *O. tamarugal* (fig. 5), all of which have the following characters: anterior margin of carapace with weak median projection (epistome; figs. 14C, 15A, C, D); pedipalp chela movable finger of male curved (figs. 26B, C, 43C, 51A); pedipalp femur and patella of male more elongated than that of female. *Orobothriurus curvidigitus* may be separated from *O. paessleri* and *O. tamarugal* by the shape of the lamina of the hemispermatophore (figs. 28B, D), the frontal crest of which is more developed and elongated in *O. curvidigitus*, but shorter in *O. paessleri* and *O. tamarugal* (fig. 28C, E, 47D). The hemispermatophore of *O. curvidigitus* differs from that of *O. quewerukana* in the slightly shorter frontal crest and absence of folds in the distal crest (figs. 28B, 40E). *Orobothriurus curvidigitus* also differs from *O. quewerukana* in the shape and granulation of the male telson vesicle: the length/height ratio is 3.72–4.23 (mean = 3.96) and only the anterior third of the ventral surface is granular in *O. curvidigitus*, whereas the length/height ratio is 3.59–4.00 (mean = 3.76) and the ventral surface is entirely granular in *O. quewerukana* (fig. 23F). The male pedipalp chela carinae are finely and sparsely granular to smooth in *O. curvidigitus*, smooth in *O. paessleri*, and finely and densely granular in *O. quererukana* and *O. tamarugal* (figs. 43D, E, 51B, C). The pigmentation pattern is the most conspicuous difference between *O. curvidigitus* and the other three species. *Orobothriurus curvidigitus* exhibits well-developed pigmentation on the carapace, tergites, metasoma, and pedipalps (figs. 11B, 12C, 13E), compared to *O. quewerukana*, in which the pigmentation, especially that of the carapace and tergites, is faint or barely discernible (fig. 41) and *O. tamarugal*, which is unpigmented (fig. 48). *Orobothriurus curvidigitus* and *O. paessleri* may be further distinguished by the dimensions of metasomal segment V and the setation of metasomal segment I: segment V is relatively elongated, its length greater than twice its width, in *O. curvidigitus* (fig. 22C), but shorter, its length less than twice its width, in *O. paessleri* (fig. 22B); two pairs of VSM macrosetae are present on segment I in *O. curvidigitus* (fig. 19A), whereas three pairs are present in *O. paessleri* (fig. 19B).

Distribution: *Orobothriurus curvidigitus* inhabits the western slopes of the Andes at 2300–3600 m (figs. 2A, 53), in the Arequipa Department, southern Peru.

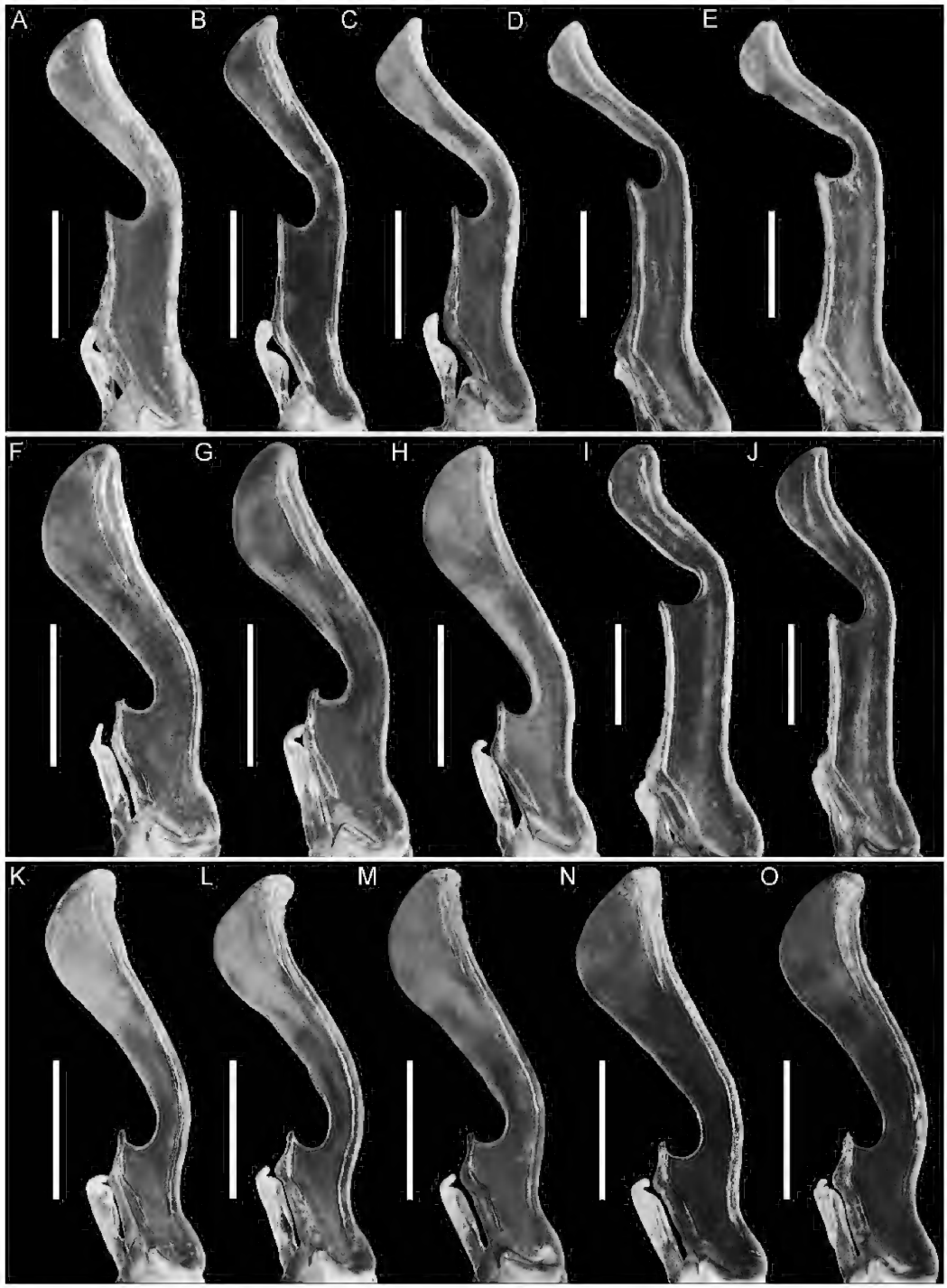

Fig. 36. *Orobothriurus* Maury, 1976, sinistral hemispermatophore, ectal aspect showing lamina. **A–C.** *Orobothriurus compagnuccii*, n. sp., ♂ holotype, ♂ paratypes (MACN-Ar). **D, E.** *Orobothriurus grismadoi* Ojanguren Affilastro et al., 2009, ♂ paratypes (MACN-Ar). **F–H.** *Orobothriurus famatina* Acosta, 2001, ♂ (MACN-Ar). **I, J.** *Orobothriurus alticola* (Pocock, 1899), ♂ (MACN-Ar). **K–O.** *Orobothriurus calchaqui*, n. sp., ♂ paratypes (MACN-Ar). Scale bar = 1 mm.

ECOLOGY: The vegetation in the areas inhabited by this species falls within the Serrania Estaparia Ecoregion, characterized by dry zones with herbaceous vegetation, cacti, shrubs, and few trees (Brack, 1986; Ochoa, 2005; fig. 2A). Three other bothriurids, *Brachistosternus ehrenbergii* Gervais, 1841, and two undescribed species of *Brachistosternus*, also occur in this area.

REMARKS: We examined populations of an undetermined *Orobothriurus* species, apparently related to *O. curvidigitus*, from Cotahuasi and Chuquibamba in the Arequipa Department, Peru, and Lucanas in the Ayacucho Department. Lourenço and Dastych (2001: 54) listed the record from Chuquibamba under "*O.* aff. *curvidigitus*" and stated that it is "probably a new species." We cannot establish the identity of these specimens until more material becomes available, however.

Orobothriurus famatina Acosta, 2001
Figures 36F–H, 54

Orobothriurus alticola: Maury 1976: 17 (part); Cei, 1982: 660, 669 [misidentification].

Orobothriurus famatina Acosta *in* Acosta and Ochoa, 2001: 205–211, figs. 4–14; Ochoa, 2004a: 43, 52, 55, 73, table 1; Ojanguren Affilastro, 2005: 177–181, figs. 458–466, 477, 488, 663, table 15.

TYPE MATERIAL: **ARGENTINA: La Rioja Province:** *Famatina Department*: Holotype ♂ (MACN-Ar 9932), Sierra de Famatina, Rio Oro canyon, path to Mina El Oro, 29°06′S 67°42′W, 2450 m, 6.xii.1998, L. Acosta, M. Acosta and G. Repossi. Paratypes: same data, 1 ♂, 1 ♀ (LEA 240), 1 ♂ (CDA 051), 1 ♂ (MHNC); Famatina, iv.1951, R. González Amorío, 1 ♀ (MACN-Ar 6844); Mina El Oro, Chilecito, ii.1956, M.E. Galiano, 1 ♀ (MACN-Ar 6843); Sierra de Famatina, path to Mina La Mejicana, 3060 m, 5.xii.1998, L. Acosta, M. Acosta, and G. Repossi, 1 ♀ (CDA 050), 1 ♀ (MACN-Ar 9933), 1 ♀ (MHNC).

NEW RECORDS: **ARGENTINA: La Rioja Province:** *Famatina Department*: Sierra de Famatina, Cuevas de Noronha (path to La Mejicana mine), 28°55′31″S 67°40′23″W, 2846 m, 29.i.2006, L. Piacentini, L. Compagnucci, and A. Ojanguren Affilastro, 2 ♂, 6 ♀, 12 juv. (MACN-Ar), 2 ♀ (AMNH [LP 5846]).

DIAGNOSIS: *Orobothriurus famatina* is most closely related to *O. calchaqui* (fig. 5), from which it differs in the following respects. *Orobothriurus famatina* possesses one ML macroseta on metasomal segment IV and only 10% of the specimens possess one DL macroseta on segment III (absent in 90%), whereas *O. calchaqui* possesses two or three macrosetae on segment IV and 70% of the specimens possess one DL macroseta on segment III (absent in 30%). There are also differences in the trichobothrial pattern. Pedipalpal chela trichobothria *db* and Et_3 are located in the same axis as, or slightly distal to *Est* in 70% and 30% of the specimens of *O. famatina*, respectively, but always located proximal to *Est* in *O. calchaqui*. Pedipalp patella trichobothrium em_2 is located in the same axis as, or distal to em_1 in 70% of the specimens of *O. famatina*, but proximal to em_1 in 80% of the specimens of *O. calchaqui*. *Orobothriurus famatina* may be differentiated from *O. compagnucci* by the more elongated apex of the hemispermatophore lamina: the apex comprises 66.6–68.48% (n = 3, mean = 67.02%) of the lamina in *O. famatina* (fig. 36F–H) and 52.17%–54.54% (n = 3; mean = 52.98%) in *O. compagnuccii* (fig. 36A–C). The two species can also be separated by the VL and VSM carinae of metasomal segment I and sternite VII in the male, which are well developed in *O. famatina*, and weakly developed to absent in *O. compagnuccii* (fig. 18F).

DISTRIBUTION: *Orobothriurus famatina* is known only from high altitudes (2500–3200 m) of the Sierra Famatina, a mountain range close to the Andes, in La Rioja Province of central-western Argentina (figs. 3G, 54).

ECOLOGY: This species inhabits an area of grassland and shrub steppe that belongs to the Prepuna and Altoandina phytogeographic provinces (Cabrera and Willink, 1980; fig. 3G). It occurs in sympatry with another bothriurid, *Bothriurus olaen* Acosta, 1997 (Ojanguren Affilastro, 2005).

Orobothriurus grismadoi Ojanguren Affilastro et al., 2009
Figures 4B, 13G, 21E, 23E, 36D, E, 54

Orobothriurus grismadoi Ojanguren Affilastro et al., 2009: 29–35, figs. 1, 3–13, 15–17, 20–24, 35, tables 1, 2.

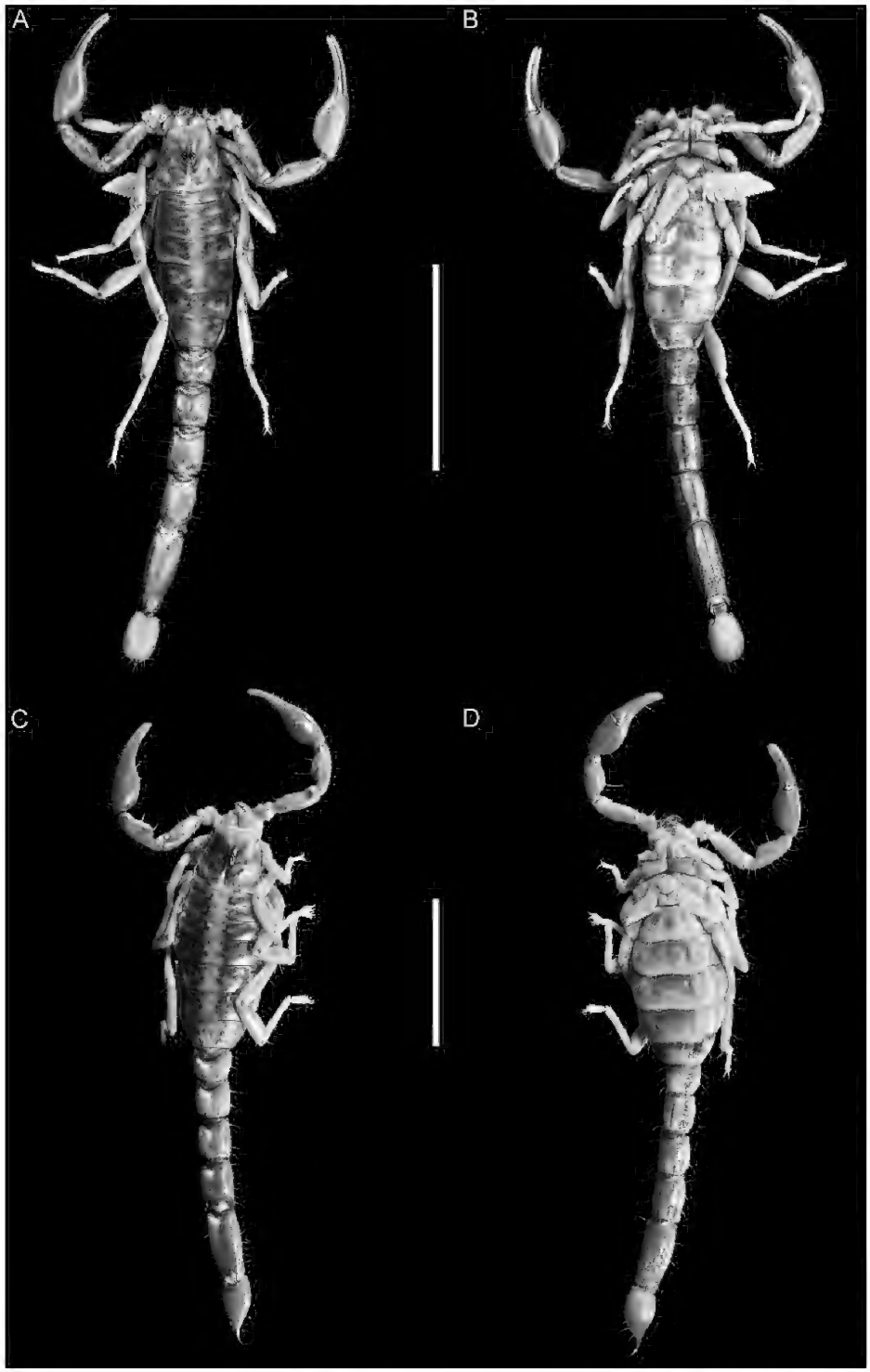

Fig. 37. *Orobothriurus huascaran*, n. sp., habitus. **A, B.** Paratype ♂ (MACN-Ar). **C, D.** Paratype ♀ (MACN-Ar). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 10 mm.

TYPE MATERIAL: **ARGENTINA: Mendoza Province:** *Malargüe Department*: Holotype ♂ (MACN-Ar 17986), Cerro Nevado, 35°35′45.06″S 68°30′24.12″W, 3130 m, 25.ii.2006, F. Fernández Campón and S. Lagos Silnik. Paratypes: same data, 6 ♂, 2 ♀ (MACN-Ar 17987), 2 ♂ (CDA), 1 juv. (IADIZA); Cerro Nevado, 35°36′04.08″S 68°30′44.28″W, 2900 m, 16.xi.2004, G. Flores, 1 ♀ (CDA), 2949 m, 7.i.2006, F. Fernández Campón and S. Lagos Silnik, 1 juv. (IADIZA); Cerro Nevado, 35°36′02.46″S 68°30′40.92″W, 2953 m, ii.2006, F. Fernández Campón and S. Lagos Silnik, 1 ♂ (AMNH), same data except 25.ii.2006, 5 ♂ (IADIZA), 1 ♂ (AMNH).

NEW RECORDS: **ARGENTINA: Mendoza Province:** *Malargüe Department*: Cerro Nevado, road to antennas, SW face of mountain, 35°35′58.6″S 68°30′43.9″W, 2984 m, 23.iv.2011, C.I. Mattoni and M. Vivanco, UV sampling on rocky slopes, with small bushes and shrubs, no moon, 3°C, winds up to 45 km/h, wind chill factor −10°C, specimens walking or sitting on rocks, 5 ♂, 6 ♀, 4 juv. (LBRE), 4 juv. (AMNH), 1 juv. (AMNH [LP 10968]).

DIAGNOSIS: *Orobothriurus grismadoi* is similar to *O. alticola* in pigmentation pattern, external morphology, and hemispermatophore. The two species may be separated by the shape of the hemispermatophore: in *O. grismadoi*, the apex is more slender and the angle it forms with the rest of the distal lamina more acute (fig. 36D, E) than in *O. alticola* (fig. 36I, J). Additionally, the apex comprises 42.70%–45.69% (n = 7; mean = 44.17%) of the lamina in *O. grismadoi* and 40.87–46.08% (n = 20; mean = 43.88%) in *O. alticola*. Males of *O. grismadoi* may also be recognized by the slender telson vesicle, with a concave dorsal surface; the vesicle is broader, with a flat dorsal surface, in males of *O. alticola* (fig. 23A, E). *Orobothriurus grismadoi* is also more densely pigmented, with tergite VII entirely pigmented (fig. 13G), compared to *O. alticola*, in which tergite VII exhibits paired lateral spots of pigmentation delimiting an unpigmented median stripe (fig. 13F).

DISTRIBUTION: *Orobothriurus grismadoi* is the southernmost species of the genus. It is known only from the Cerro El Nevado, an isolated mountain range, 200 km east of the Andes, in central-western Mendoza Province, Argentina (fig. 54). The El Nevado range, with a maximum altitude of 3833 m, extends north to south between 34°S and 36°S, parallel to the Andes, and is separated from it by a plateau of 1800 m (Ojanguren Affilastro et al., 2009). El Nevado is an extinct, eroded, stratovolcano, unrelated to and younger than the Andes. The age of these volcanoes is estimated at between 2.5 and 0.01 MA (Caminos, 1999).

ECOLOGY: *Orobothriurus grismadoi* was collected in a high-altitude shrub steppe at 2900–3130 m (fig. 3D), in an area belonging to the Altoandina and Puna phytogeographic provinces (Cabrera and Willink, 1980).

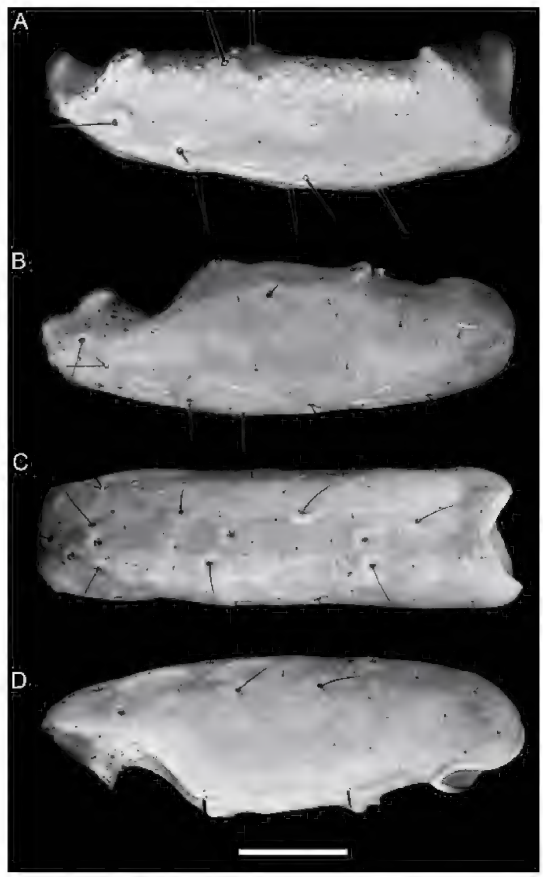

Fig. 38. *Orobothriurus huascaran*, n. sp., paratype ♂ (MHNC), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

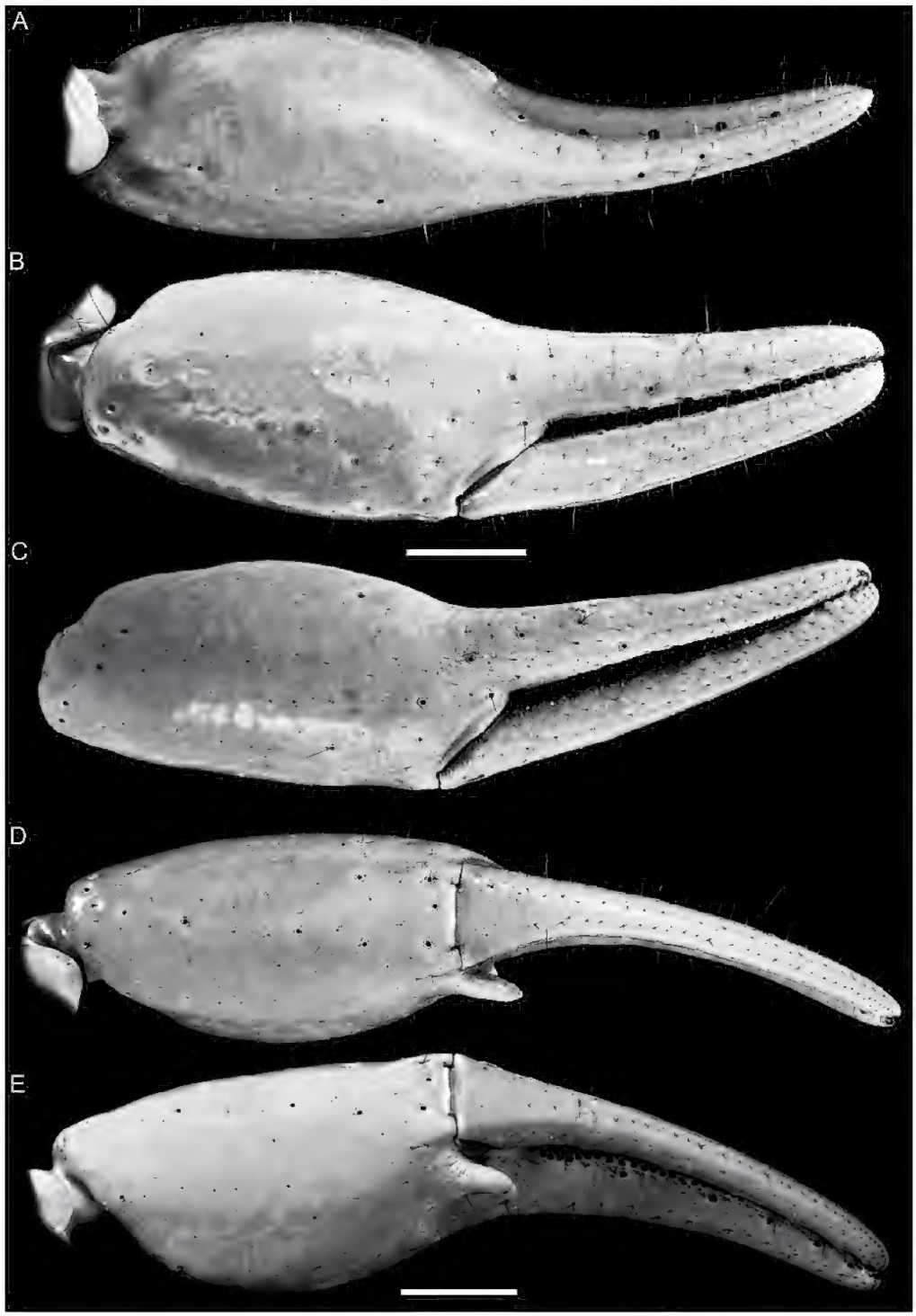

Fig. 39. *Orobothriurus huascaran*, n. sp., dextral pedipalp chela. **A, B.** Paratype ♀ (MACN-Ar). **C–E.** Paratype ♂ (MACN-Ar). **A.** Dorsal aspect. **B, C.** External aspect. **D.** Ventral aspect. **E.** Ventrointernal aspect. Scale bars = 1 mm.

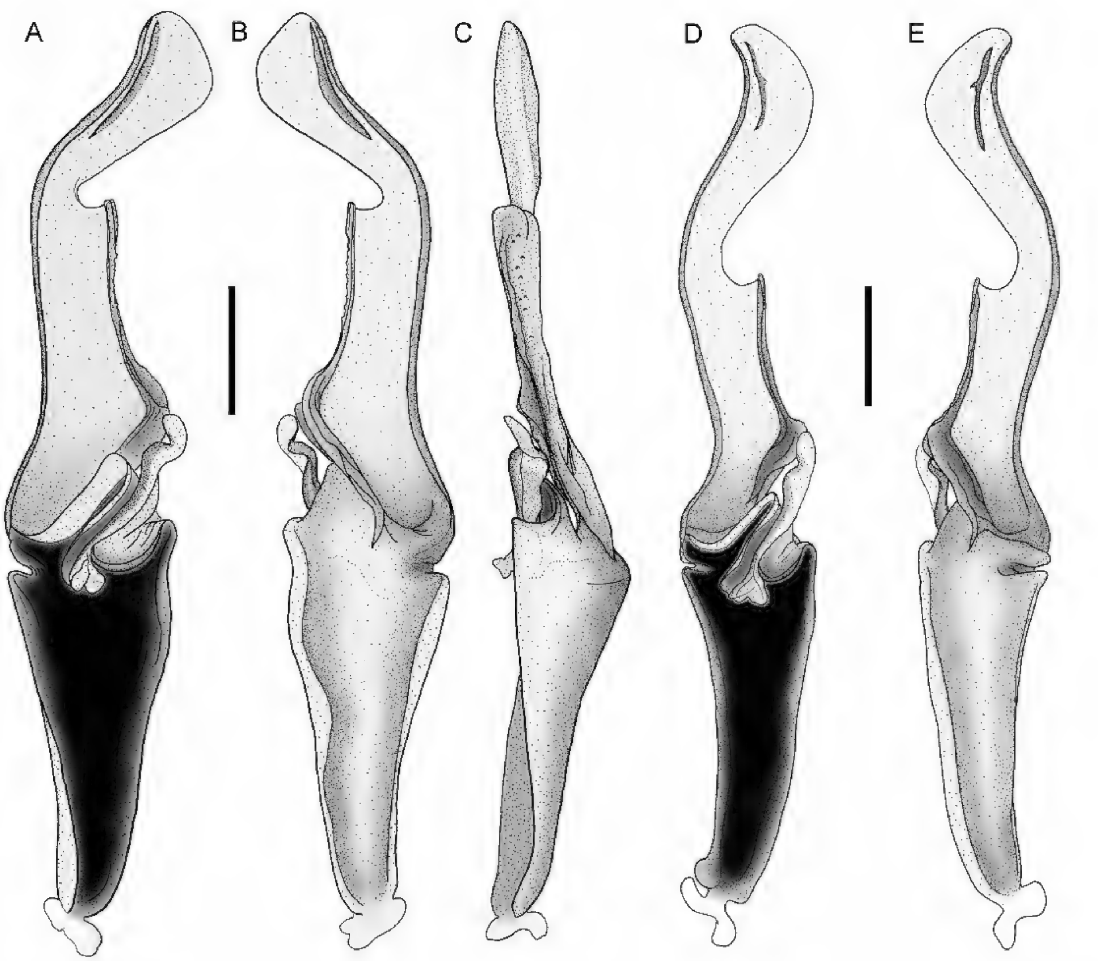

Fig. 40. *Orobothriurus* Maury, 1976, sinistral hemispermatophores. **A–C.** *Orobothriurus huascaran*, n. sp., paratype ♂ (MACN-Ar). **D, E.** *Orobothriurus quewerukana*, n. sp., paratype ♂ (MACN-Ar). **A, D.** Ental aspect. **B, E.** Ectal aspect. **C.** Dorsal aspect. Scale bar = 1 mm.

Arthropod surveys conducted using pitfall traps in the summers of 2004 and 2006 did not collect other scorpion species. A recent expedition to the area confirmed that this species is the only scorpion present and active during the summer at this altitude on the El Nevado volcano. All specimens were collected at night in rocky areas (mostly basalt and pumice), and efforts to find the species on sandy slopes (with ash and pumice fragments) surrounding these rocky habitats were unsuccessful. Despite the harsh conditions, with very low temperatures and strong winds during the night, the species is apparently active on the surface from mid-November to the end of April.

Orobothriurus huascaran, n. sp.

Figures 4D, 11C, 12A, 14D, 19D, 21F, 22D, 23D, 24C, 37–39, 40A–C, 52; table 3

Orobothriurus crassimanus: Polis, 1990: 252; Lourenço, 1997: 588 (part); Coddington and Colwell, 2001: 207; Lourenço, 2002: 400; 2003: 227; Lourenço and Qi, 2006: 290. [misidentification].

Orobothriurus paessleri: Lourenço and Dastych, 2001: 54 (part) [misidentification: 1 ♀, from Quebrada Yanganuco].

Orobothriurus sp. 2: Ochoa, 2004a: 50, 73, figs. 1, 2, 14, 21, table 1.

TYPE MATERIAL: **PERU: Ancash Department:** *Huaraz Province*: Holotype ♂ (MHNC), Cordillera Blanca, Huascarán National Park,

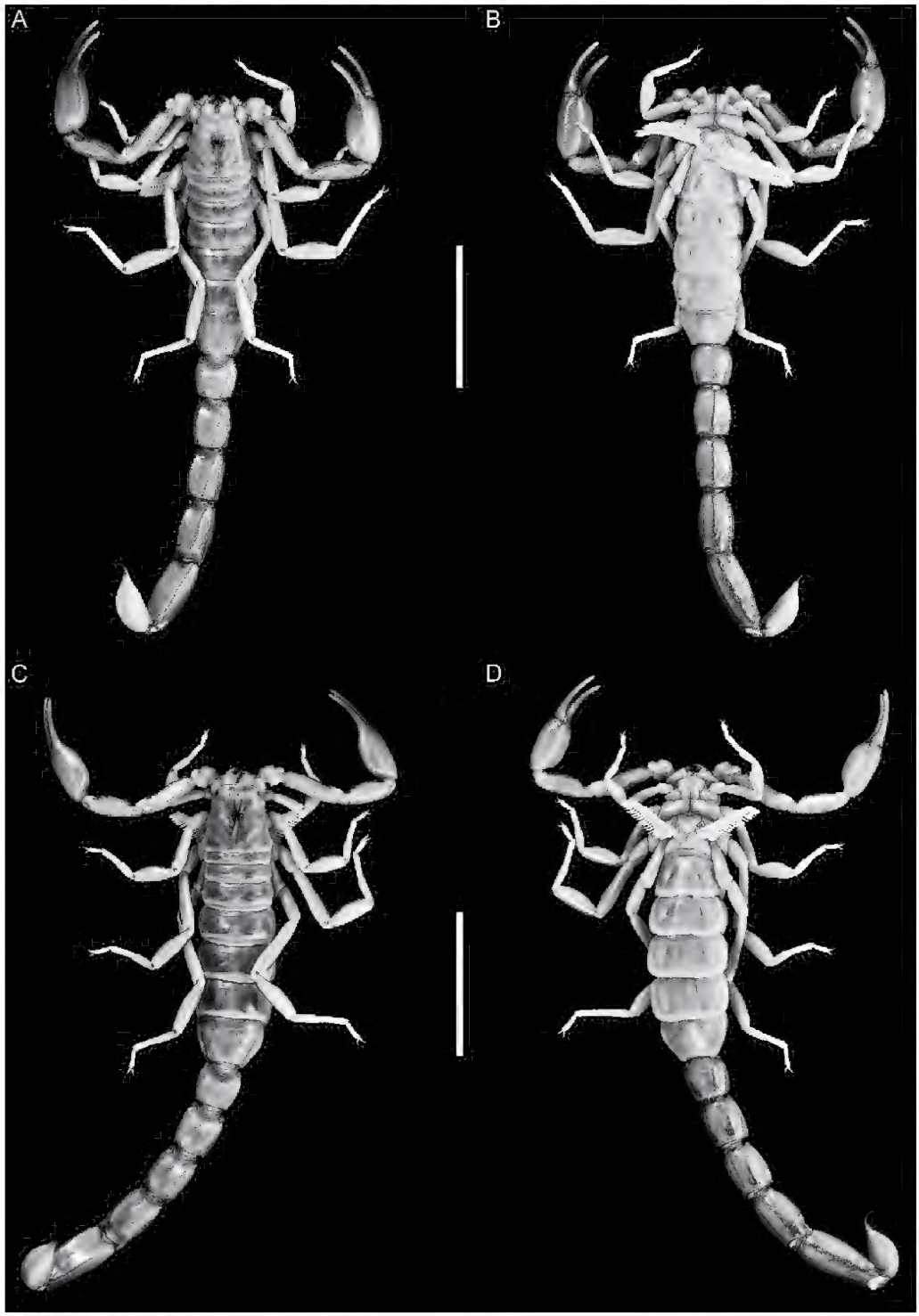

Fig. 41. *Orobothriurus quewerukana*, n. sp., habitus. **A, B.** Holotype ♂ (AMNH). **C, D.** Paratype ♀ (MHNC). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 10 mm.

TABLE 3

Selected measurements (mm) of type specimens of six new species of *Orobothriurus* Maury, 1976: *Orobothriurus calchaqui*, n. sp., *Orobothriurus compagnuccii*, n. sp., *Orobothriurus huascaran*, n. sp., *Orobothriurus quewerukana*, n. sp., *Orobothriurus ramirezi*, n. sp., and *Orobothriurus tamarugal*, n. sp.

Abbreviations: AMNH = American Museum of Natural History, New York; MACN = Museo Argentino de Ciencias Naturales "Bernardino Rivadavia," Argentina; MHNC = Museo de Historia Natural, Universidad Nacional de San Antonio Abad del Cusco, Peru; LBRE = Laboratorio de Biología Reproductiva y Evolución, Universidad Nacional de Córdoba, Argentina; MZUC = Museo de Zoología de la Universidad de Concepción, Chile.

Specimen	*O. calchaqui*		*O. compagnuccii*		*O. huascaran*		*O. quewerukana*		*O. ramirezi*		*O. tamarugal*	
Type	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Collection	MACN	MACN	MACN	MACN	MHNC	MHNC	AMNH	MHNC	MACN	LBRE	MACN	MZUC
Carapace												
Length	3.33	3.87	2.92	3.40	3.20	4.07	4.50	4.70	3.90	5.12	4.27	3.78
Anterior width	2.27	2.67	1.80	2.16	2.13	2.67	2.90	2.90	2.50	3.17	2.74	2.38
Posterior width	3.60	4.33	2.84	3.24	3.60	4.40	4.55	4.90	4.15	5.06	4.39	3.78
Chela												
Length	5.27	5.93	5.01	5.09	5.80	6.60	8.30	7.40	6.81	7.77	7.77	5.61
Width	1.40	1.67	1.29	1.36	1.40	1.73	2.30	2.00	1.83	2.32	2.44	1.46
Height	1.53	1.87	1.58	1.68	1.53	1.80	2.70	2.30	2.07	2.56	2.68	1.59
Movable finger length	3.27	3.53	2.34	2.64	3.13	3.73	4.50	4.10	3.66	4.02	4.39	3.17
Patella												
Length	3.00	3.35	2.80	2.92	3.20	3.60	4.80	4.20	3.84	4.33	4.63	3.41
Width	1.07	1.25	0.92	1.08	1.07	1.40	1.40	1.40	1.22	1.71	1.34	1.16
Femur												
Length	3.00	3.33	3.00	2.92	3.20	3.27	4.65	4.10	3.90	4.27	4.70	3.05
Width	0.93	1.00	0.80	0.96	0.87	1.13	1.20	2.25	1.16	1.52	1.16	0.98
Mesosoma												
Length	8.91	12.10	6.46	7.68	6.87	9.30	9.50	10.00	8.96	10.92	8.54	7.99
Metasoma I												
Length	1.67	1.93	1.50	2.80	1.60	2.13	2.60	2.70	2.07	2.44	2.32	2.13
Width	1.60	2.13	1.60	2.00	2.00	2.67	3.00	3.00	2.38	3.05	2.56	2.50
Metasoma II												
Length	2.13	2.33	1.70	1.80	1.97	2.27	3.10	3.00	2.44	2.56	2.74	2.38
Width	1.47	2.13	1.50	1.72	1.87	2.40	2.80	2.80	2.20	2.87	2.74	2.38

TABLE 3
(Continued)

Specimen	*O. calchaqui*		*O. compagnuccii*		*O. huascaran*		*O. quewerukana*		*O. ramirezi*		*O. tamarugal*	
Type	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype	Holotype	Paratype
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Collection	MACN	MACN	MACN	MACN	MHNC	MHNC	AMNH	MHNC	MACN	LBRE	MACN	MZUC
Metasoma III												
Length	2.40	2.60	1.98	2.00	2.17	2.47	3.30	3.00	2.62	2.74	2.99	2.44
Width	1.47	2.07	1.40	1.70	1.77	2.33	2.80	2.70	2.13	2.74	2.74	2.38
Metasoma IV												
Length	2.67	3.00	2.20	2.20	2.80	2.87	3.80	3.60	3.17	3.29	3.54	2.81
Width	1.40	2.00	1.32	1.66	1.67	2.27	2.60	2.70	1.95	2.56	2.62	2.32
Metasoma V												
Length	3.67	4.00	3.67	3.32	4.00	4.33	5.40	5.20	4.57	4.76	4.88	3.96
Width	1.27	1.73	1.22	1.62	1.67	2.27	2.30	2.60	1.89	2.50	2.50	2.13
Height	1.53	2.00	1.10	1.38	1.40	2.00	1.90	2.10	1.71	2.01	1.95	1.77
Telson												
Total length	4.53	4.47	3.48	3.60	4.80	5.47	5.95	5.55	5.13	5.91	6.04	4.63
Vesicle length	3.53	3.47	2.68	2.68	3.80	4.34	4.65	4.20	4.09	4.45	4.70	3.35
Vesicle width	1.27	1.80	1.28	1.60	1.60	2.27	2.10	2.30	1.89	2.68	2.38	2.01
Vesicle height	1.07	1.33	0.96	1.24	1.40	1.87	1.55	1.85	1.71	2.13	1.71	1.43
Aculeus length	0.99	1.00	0.80	0.92	1.00	1.13	1.30	1.35	1.04	1.46	1.34	1.28
Metasoma												
Total Length	17.07	18.33	14.53	15.72	17.34	19.54	24.15	23.05	20.00	21.7	22.51	18.35
Total length	29.31	34.30	23.91	26.80	27.41	32.91	38.15	37.75	32.87	37.75	35.32	30.12

Ishinca, 09°22′49″S 77°27′39″W, 4100 m, 19.vi.1998, J.A. Ochoa. Paratypes: *Huaraz Province*: Cordillera Blanca, Huascarán National Park, Ishinca, from 09°22′49″S 77°27′39″W, 4050 m, to 09°22′28″S 77°24′36″W, 4910 m, 18–19.vi.1998, J.A. Ochoa, 3 ♂, 3 ♀, 2 juv. ♂ (MHNC); Quebrada Querococha, Catac [09°32′S 77°24′W], 3900 m, vi.1981, W.R. Lourenço, 1 ♂, 2 ♀ (MHNG); Querococha, 3850 m, 16.iii.1994, M. Etonti, 1 ♂ (MRSN); Pastoruri [09°51′S 77°12′W], 4900 m, 18.iii.1994, M. Etonti, 1 ♂ (MRSN). *Huaylas Province*: Laguna Parón [08°59′43″S 77°40′41″W, 4160 m], 16.v.2010, R. Pinto da Rocha and D. Silva, 2 ♂ (MZSP), 1 ♂, 1 ♀ (MUSM), 2 juv. (AMNH [LP 10709, 10713]). *Yungay Province*: Llanganuco, 4000 m, 2.i.1976, O. F. Francke, 1 ♂, 5 ♀ (MACN-Ar 17889); same locality, 3600–3850 m, 15.iii.1994, M. Etonti, 2 ♀ (MRSN); same locality, 3810 m, vi.1997, F. Pribik, 1 ♀, 1 juv. (FKPC); Llanganuco, Huascarán National Park, 09°04′42″S 77°38′57″W, 3800–4000 m, 28–29.ix.1998, J.A. Ochoa, *Polylepis* forest, 1 ♂, 3 ♀ paratypes (MHNC), 1 ♂, 1 ♀ (AMNH), 1 ♂, 1 ♀ (LBRE); Chinancocha, Llanganuco, 09°04′18″S 77°38′38″W, 3844 m, 15.v.2010, R. Pinto da Rocha and D. Silva, 1 ♀ (MZSP).

Additional Material: **PERU: Ancash Department:** *Carhuaz Province*: Huascarán National Park, Aquilpo, Porganillo, 09°19′02″S 77°27′32″W, 3730 m, 15.vi.1998, J.A. Ochoa, 1 ♂, 3 ♀, 2 juv. ♂, 1 juv. ♀ (MHNC). *Huaraz Province*: Cordillera Blanca, Huascarán National Park, Ishinca ravine, 09°22′49″S 77°27′39″W, 4100 m, 19.vi.1998, J.A. Ochoa, 1 ♂, 3 juv. (MHNC). *Huaylas Province:* Laguna Parón [08°59′58″S 77°41′09″W, 4180 m], ii.1981, W.R. Lourenço, 1 juv. ♀ (MHNG). *Recuay Province*: Huama, 4200 m, 22.viii.1972, P. Brignoli, 6 ♀ [mislabeled "2 ♂, 4 ♀"], 14 first instar juv. (MHNG). *Yungay Province*: Llanganuco, 4300 m, ii.1981, W.R. Lourenço, 3 ♀ (MHNG), 4400–5500 m [see discussion on the altitude record in Scorpiones], ii.1981, W.R. Lourenço, 2 ♀ (MHNG); Llanganuco, Huascarán National Park, 09°04′42″S 77°38′57″W, 3800–4000 m, 28–29.ix.1998, J.A. Ochoa, *Polylepis* forest, 1 ♂, 2 ♀ (MHNC).

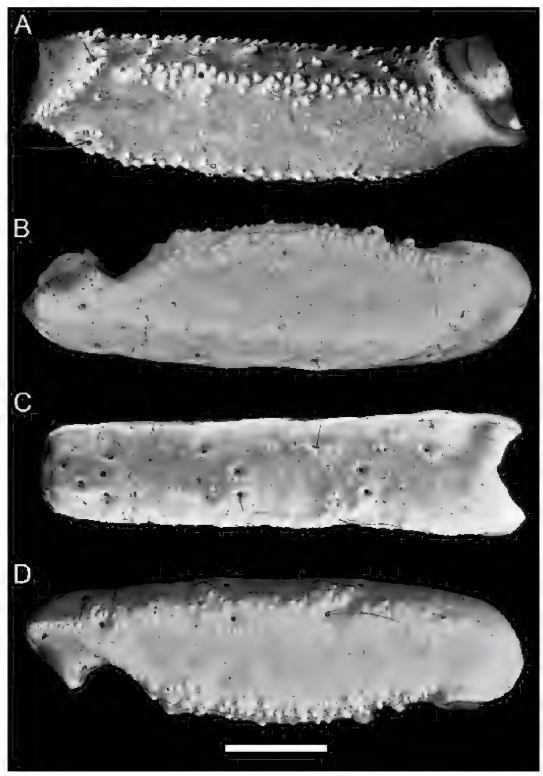

Fig. 42. *Orobothriurus quewerukana*, n. sp., paratype ♂ (MHNC), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

Etymology: The specific name is a noun in apposition derived from the Huascarán National Park, Ancash Department, central Peru, where the type locality of this species is situated. This area belongs to the Cordillera Blanca, the world's highest tropical mountain range.

Diagnosis: *Orobothriurus huascaran* may be distinguished from other species of the genus by the following combination of characters. The distal border of the apex of the hemispermatophore is slightly rounded, the internal lateral projection of the frontal crest vestigial, and the external lateral projection well developed in *O. huascaran* (fig. 40A–C) compared to other species in which the distal border of the apex is subtriangular, and both lateral projections of the frontal crest are well developed. Pedipalp chela trichobothrium *Db* is situated slightly closer to *Dt* than to Eb_3 in *O.*

Fig. 43. *Orobothriurus quewerukana*, n. sp., dextral pedipalp chela. **A, B.** Paratype ♀ (MHNC). **C–E.** Paratype ♂ (MHNC). **A.** Dorsal aspect. **B, C.** External aspect. **D.** Ventral aspect. **E.** Ventrointernal aspect. Scale bar = 1 mm.

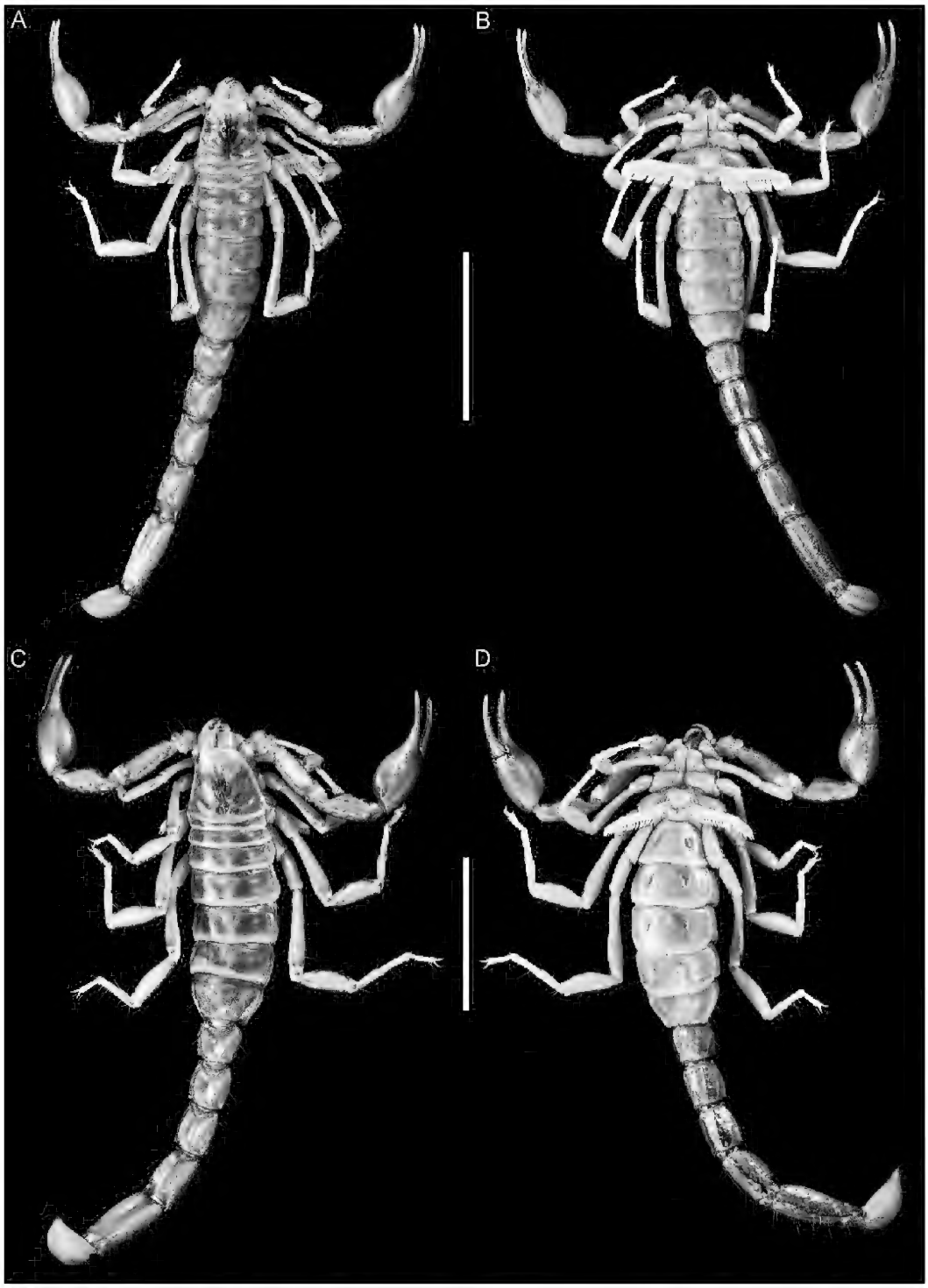

Fig. 44. *Orobothriurus ramirezi*, n. sp., habitus. **A, B.** Paratype ♂ (MACN-Ar). **C, D.** Paratype ♀ (MACN-Ar). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 10 mm.

huascaran (fig., 39C), but equidistant between *Dt* and Eb_3 in other species. The VM and VL carinae are restricted to the posterior two-thirds of metasomal segment V in *O. huascaran* (fig. 21F), absent in *O. wawita* and complete in all other species. *Orobothriurus huascaran* is similar to four other Peruvian species, *O. atiquipa*, *O. curvidigitus*, *O. paessleri*, and *O. quewerukana*, in several respects. Pedipalp chela trichobothrium Et_3 is situated proximal to *Est*, and *Esb* situated between Eb_2 and Eb_3 in all these species, except *O atiquita*, in which *Esb* is situated dorsal to Eb_2. The hemispermatophore of these species exhibits an elongated frontal crest, with a strongly curved, S-shaped apex and a basal lobe with a well-developed terminal process. *Orobothriurus huascaran* may be distinguished by the presence of VM and VSM carinae on sternite VII and metasomal segment I (fig. 19D), which are absent in *O. atiquipa*, *O. curvidigitus*, *O. paessleri*, and *O. quewerukana* (figs. 18A, 19A, C). Additionally, the pedipalp chela movable finger of the male is straight in *O. huascaran* (fig. 39C) and curved in *O. curvidigitus*, *O. paessleri*, and *O. quewerukana* (fig. 26B, C, 43C).

DESCRIPTION: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 26.43–30.79 mm (n = 9, mean = 27.97 mm); ♀, 30.05–33.21 mm (n = 10, mean = 31.65 mm).

Color: General color yellowish with dark brown spots (fig. 4D). Carapace densely pigmented, especially laterally and posteriorly; anterior margin with narrow stripe (fig. 37A, C); median lateral surfaces densely pigmented; posterolateral surfaces with dense reticulate pigmentation; median ocular tubercle and lateral ocelli dark brown to black; posterior half of anteromedian longitudinal sulcus, median ocular tubercle and anterior half of posteromedian longitudinal sulcus densely pigmented; posterolateral sulci unpigmented. Chelicerae, dorsal surfaces with fine reticulate pigmentation, contiguous distally near base of movable finger; movable finger external surface pigmented. Pedipalp coxa and trochanter faintly pigmented; femur densely pigmented along margins with small unpigmented areas in proximal half; patella densely and irregularly pigmented; chela manus with faint longitudinal stripes along carinae, contiguous at base of movable finger. Legs, femur, and patella densely pigmented prolaterally; tibia and basitarsus faintly pigmented. Tergites I–VI each with two dark spots sublaterally along entire margin and pretergites, delimiting broad, unpigmented median stripe; VII with similar pattern and additional reticulate pigmentation (fig. 12A). Sternum, genital opercula and pectines unpigmented. Sternites III–VI unpigmented, VII with two dark stripes sublaterally (fig. 11C). Metasomal segments I–III, dorsal surfaces each with two subtriangular spots medially, separated by narrow unpigmented line on I, contiguous or separated on II, contiguous on III, becoming broader posteriorly and often connected to median pigmentation by fine reticulate pigmentation, with additional pigmentation along DL carinae; lateral surfaces densely pigmented, especially in anterior half, posterior half with reticulate pigmentation (figs. 11C, 12A); ventral surface with narrow VM stripe, not contiguous with lateral pigmentation, and with two dark VL stripes, becoming broader in posterior half and extending to LIM carinae. Segment IV as for segment III, but with dorsal surface more densely reticulate. Segment V, dorsal surface faintly pigmented along DL carinae; lateral surfaces with dense reticulate pigmentation; ventral surface with three dark stripes, two VL and one VM, becoming slightly broader in posterior half but not contiguous with lateral pigmentation (fig. 11C). Telson vesicle with narrow VM and two broad VL stripes, separated by two narrow unpigmented stripes; aculeus sclerotized, dark reddish-brown.

Chelicerae: Movable finger with two subdistal teeth.

Carapace: Surfaces smooth in anterior third, finely granular elsewhere. Anterior margin linear, without median notch (fig. 14D). Anteromedian longitudinal sulcus complete, well developed, more so in ♂; median ocular and posteromedian longitudinal sulci well developed; posterolateral sulci obsolete. Median ocular tubercle raised, situated anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, DI and VI carinae complete, finely granular; DE carina obsolete, smooth (fig. 38A); internal surface finely and sparsely granular medially; other intercarinal surfaces smooth. Patella, DI and VI carinae obsolete, finely granular (♂) or smooth (♀) (fig. 38B–D); internal surface with two prominent granules distally, the larger adjacent to trichobothrium *i*; other intercarinal surfaces smooth. Chela manus slender, fingers relatively elongated (fig. 39); length/width ratio: ♂, 3.46–4.14 (n = 11, mean = 3.76), ♀, 3.37–4.14 (n = 20, mean = 3.74); D, DS, DMA, DI, and VM carinae obsolete; intercarinal surfaces smooth; internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (fig. 39A, D); fingers, dentate margins each with median denticle row and 4–5 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27 (figs. 38, 39). Chela trichobothrium Et_3 situated proximal to *Est*; *Esb* situated between Eb_2 and Eb_3 (fig. 39).

Tergites: Tergites I–VI, surfaces finely granular. Tergite VII tetracarinate, paired DL carinae restricted to posterior two-thirds of segment, paired DSM carinae to posterior half; surfaces more coarsely and densely granular in posterior half.

Legs: Femur and patella, prolateral surfaces finely granular, retrolateral surfaces smooth. Femur, ventral carinae weakly developed; other carinae absent. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 17–20 (n = 30, mode = 18); ♀, 14–17 (n = 56, mode = 15).

Sternites: Sternites III–VI, surfaces smooth; spiracles small, narrow. Sternite VII, surface smooth in anterior half, granular in posterior half; VL and VSM carinae well developed (♀, fig. 19D) or obsolete (indistinct from granulation) to absent (♂).

Metasoma: Segment I, DL carinae complete, more developed in ♀; usually one pair of DL macrosetae; ML carinae complete; two pairs of ML setae; LIM carinae obsolete, entirely smooth or with few granules in posterior third; VL and VSM carinae complete, obsolete, smooth (♂) or granular (♀); three pairs of VL and two or three pairs of VSM macrosetae (fig. 19D). Segments II and III, DL carinae complete; one pair of DL macrosetae; ML carinae restricted to posterior half (♂) or complete but less developed than on segment I (♀); two pairs of ML macrosetae; LIM carinae reduced to one or two granules posteriorly (♀) or absent (♂) on segment II, absent on III; VL carinae as for segment I, but less developed (♀) or absent (♂) on II, obsolete (♀) or absent (♂) on III; VSM carinae as for segment I, but less developed on II, obsolete (♀) or absent (♂) on III; three pairs of VL and VSM macrosetae. Segment IV, DL carinae complete; one or (usually) two pairs of DL macrosetae; ML carinae reduced to few small granules poste-

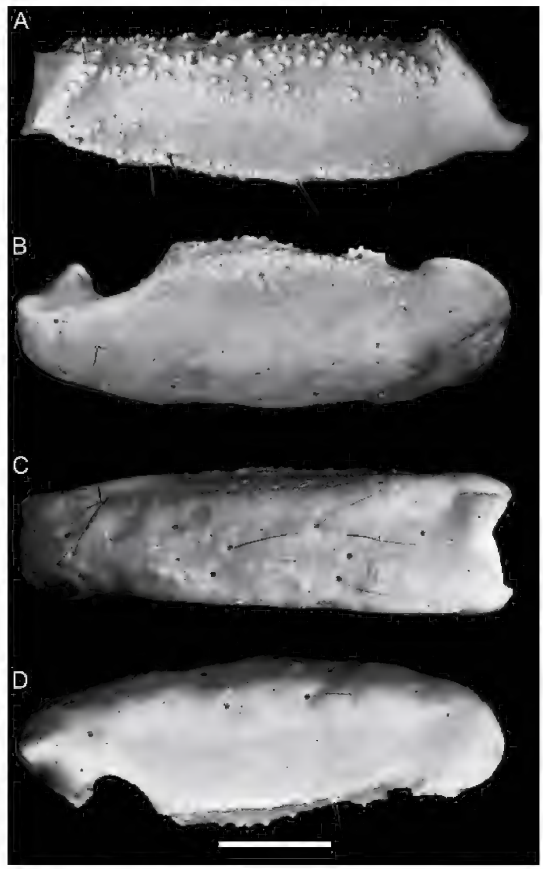

Fig. 45. *Orobothriurus ramirezi*, n. sp., paratype ♂ (MACN-Ar), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

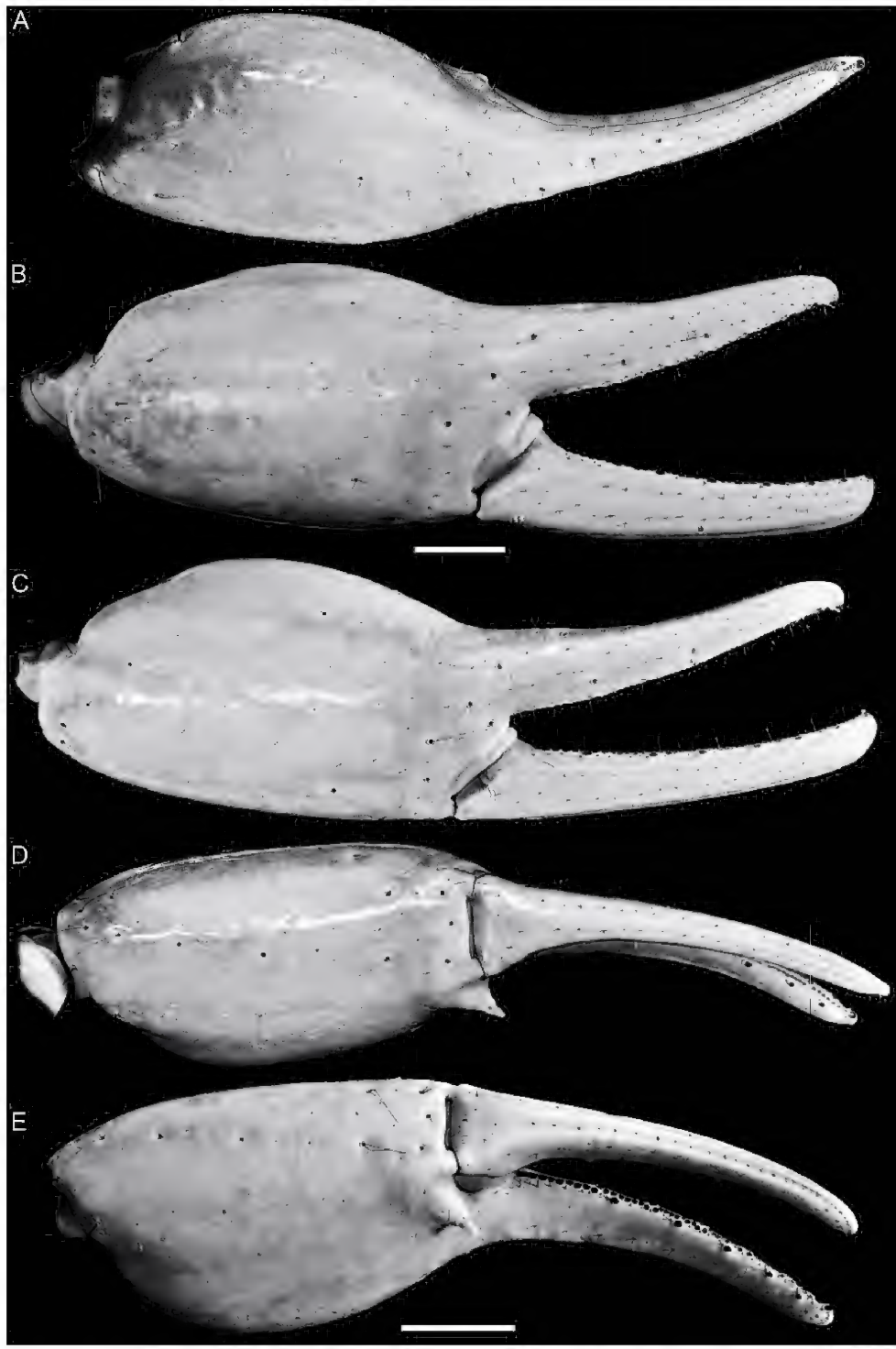

Fig. 46. *Orobothriurus ramirezi*, n. sp., dextral pedipalp chela. **A, B.** Paratype ♀ (MACN-Ar). **C–E.** Paratype ♂ (MACN-Ar). **A.** Dorsal aspect. **B, C.** External aspect. **D.** Ventral aspect. **E.** Ventrointernal aspect. Scale bar = 1 mm.

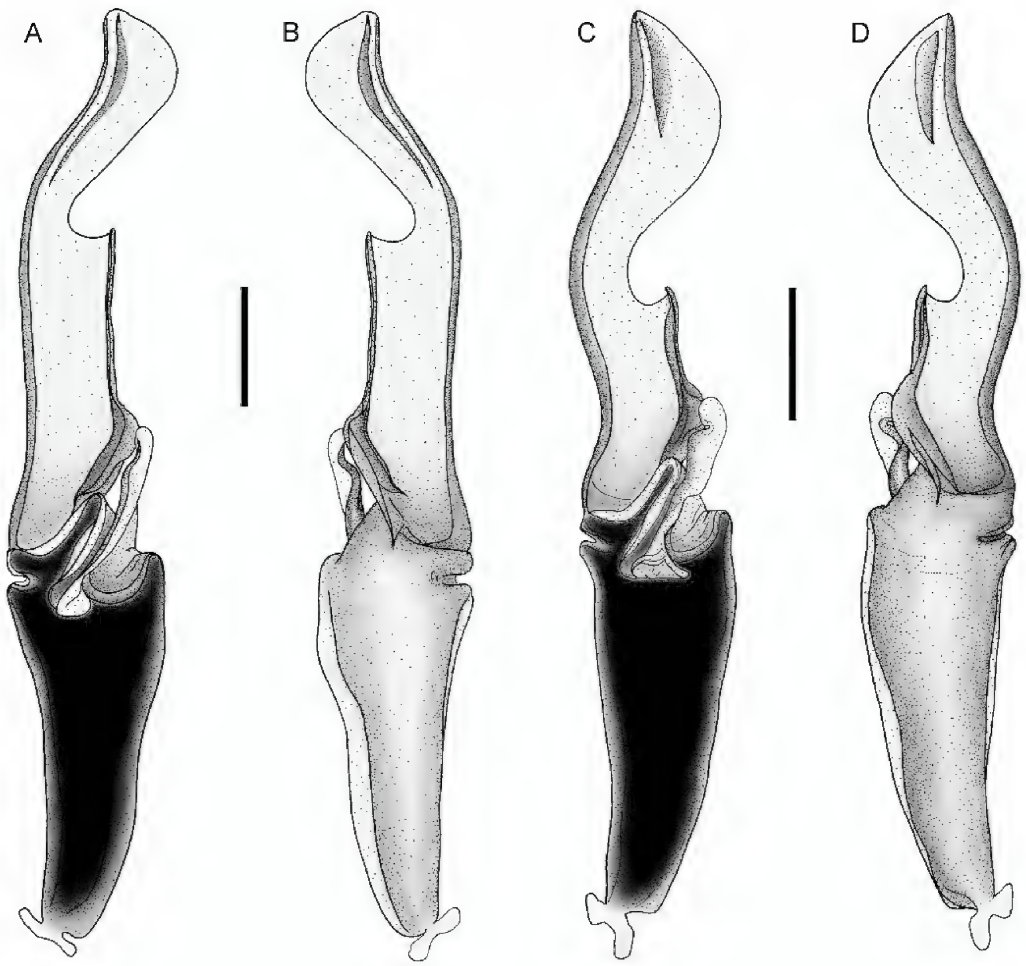

Fig. 47. *Orobothriurus* Maury, 1976, sinistral hemispermatophore. **A, B.** *Orobothriurus ramirezi*, n. sp., paratype ♂ (MACN-Ar). **C, D.** *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar). **A, C.** Ental aspect. **B, D.** Ectal aspect. Scale bar = 1 mm.

riorly; LIM carinae absent; VL and VSM carinae absent; three pairs of VL and four pairs of VSM macrosetae. Segment V, length/width ratio: ♂, 2.07–2.40 (n = 5, mean = 2.17), ♀, 1.71–2.02 (n = 7, mean = 1.87); DL carinae reduced to three or four prominent granules anteriorly; lateral intercarinal surfaces smooth (♂) or finely and sparsely granular medially near VL carinae (♀); VL carinae usually restricted to posterior two-thirds (but complete, weakly granular in anterior third in some ♀), with terminal granules more developed; VSM and VM carinae usually obscured by surface granulation in posterior two-thirds (fig. 21F), but VM carinae faintly evident in some ♀ (fig. 21D); four pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin; ventral intercarinal surfaces densely granular in posterior two-thirds, more so in ♀, granules more acute in ♂.

Telson: Length/height ratio: ♂, 2.86–3.52 (n = 11, mean = 3.24); ♀, 2.61–3.39 (n = 19, mean = 3.04). Vesicle slightly elongated (♂, fig. 23D) or globose (♀, fig. 24C); dorsal surface smooth, flat, gland not apparent (♂); ventral surface smooth (♂) or granular in anterior third (♀). Aculeus short and curved.

Hemispermatophore: Apex shorter than frontal crest, distal border slightly rounded;

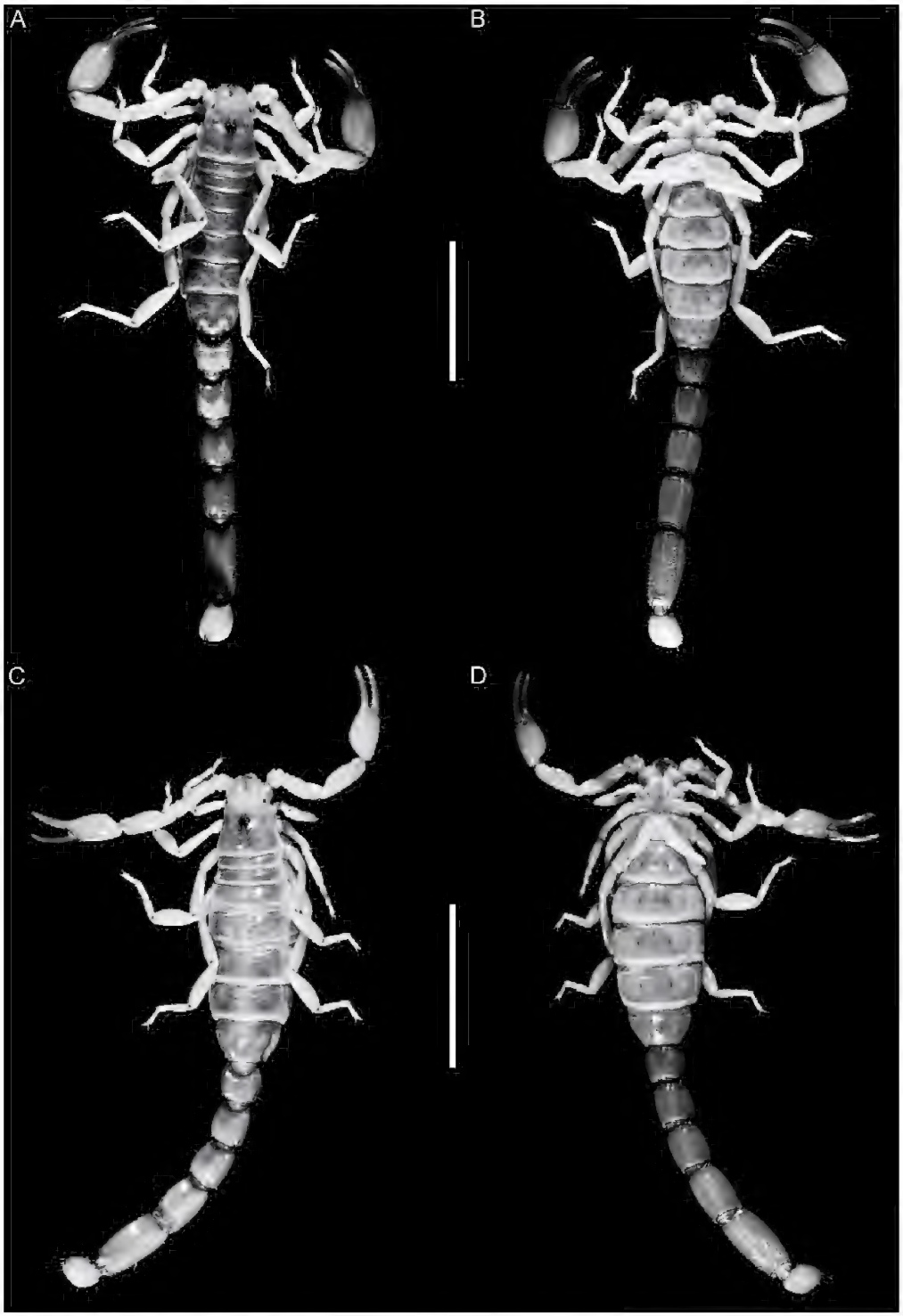

Fig. 48. *Orobothriurus tamarugal*, n. sp., habitus. **A, B.** Holotype ♂ (MACN-Ar). **C, D.** Paratype ♀ (LBRE). **A, C.** Dorsal aspect. **B, D.** Ventral aspect. Scale bars = 10 mm.

distal crest curved like ventral margin. Frontal crest elongated; basal part oblique; distal part parallel to ventral margin of lamina, lateral projections slightly undulated and larger than basal part, ental lateral projection vestigial, ectal lateral projection complete. Basal lobe, terminal process extending to constriction of frontal crest (fig. 40A–C).

DISTRIBUTION: *Orobothriurus huascaran* is endemic to the Ancash Department of central Peru (fig. 52). All known localities of this species occur in the Cordillera Blanca mountain range of the western Andes, the world's highest tropical mountain range (fig. 3F). This species has been collected from 3730 m (Porganillo, trekking route to Aquilpo mountain) to 4910 m (Ishinca ravine). It is present above 4050 m in the Ishinca area, but more abundant at 4100 m; only four specimens were found above 4500 m. The record of this species from Laguna Parón is currently the northernmost record for the genus *Orobothriurus*. The record from the Ishinca ravine is the world's highest record for a scorpion.

ECOLOGY: The area inhabited by *O. huascaran* represents typical Puna vegetation with shrub steppe, grasses and small patches of *Polylepis* spp. forest ("queñua" in Quechua), situated at 3800–4200 m (fig. 3F). All specimens were found under stones during the day. No other scorpion species have been recorded in the area.

REMARKS: The female specimen from Quebrada Yanganuco, listed under *O. paessleri* by Lourenço and Dastych (2001: 54), is probably conspecific with *O. huascaran*, n. sp., based on the known distribution of this species.

Orobothriurus paessleri (Kraepelin, 1911)
Figures 13A, B, 15A, 19B, 21B, 22B, 26B, 28C, E, 53

Bothriurus paessleri Kraepelin, 1911: 91, 98, 99, figs. 8, 9a, 9b; Mello-Leitão, 1931: 92; 1932: 34; 1934: 63; 1945: 181; Bücherl, 1953: 117; Aguilar and Meneses, 1970: 2; Maury, 1973: 110.

Bothriurus (*Andibothriurus*) *paessleri*: Bücherl et al., 1963: 216.

Orobothriurus paessleri: Maury, 1976: 19, 20, figs. 25–33, table I; 1981: 105; Francke, 1977: 75; Kovařík, 1998: 101; Acosta and Ochoa, 2000: 136, 143; Lowe and Fet, 2000: 36; Acosta and Ochoa, 2001: 205; Ochoa and Acosta, 2002a: 102, fig. 9; Ochoa, 2004a: 52, 55, 73, figs. 1, 2, 21, table 1; Ochoa, 2005: 55, figs. 7, 10, table 2.

Orobothriurus curvidigitus: Lourenço and Dastych, 2001: 54 [misidentification: 3 ♀ from Mejía].

TYPE MATERIAL: **PERU: Arequipa Department:** *Islay Province*: Syntypes: 1 ♂, 3 ♀ (ZMH), "Kataringo" [Catarindo], near Mollendo [17°00′58″S 72°02′03″W, 34 m?], 25.ii.1907, R. Paessler.

NEW RECORDS: **PERU: Arequipa Department:** *Camaná Province*: S of Camaná, 7.viii.1977, L. Peña, 1 ♀ (MACN-Ar). *Islay Province*: Lomas de Mejía [17°02′S 71°51′W, 530 m], 1–3.ii.2000, J.A. Ochoa, 1 ♂, 2 ♀, 3 juv. (MHNC), 1 ♂, 1 ♀ (CDA 168); Lomas de Mejía, Challascapa [17°02′S 71°51′W, 550 m], 3.iii.2004, R. Gutierrez and J.A. Ochoa, 2 juv. (AMNH [LP 3057]); near Mejía, 17°07′S 71°55′W, 350–500 m, 15.i.1956, Koepcke, Park loma, Kp 1350, 1 ♂, 1 subad. ♂, 2 juv. ♂, 2 juv. ♀ (ZMH A18/101) [misidentified by W.R. Lourenço as "*O. curvidigitus*"]; Lomas de Yuta, Matarani, 16°57′16″S 72°04′10″W, 570 m, 12.iii.1998, E. Ponce and J.A. Ochoa, 1 ♀ (MHNC).

DIAGNOSIS: *Orobothriurus paessleri* is most closely related to *O. curvidigitus*, *O. quewerukana* and *O. tamarugal* (fig. 5), from which it may be separated as follows. Metasomal segment V is markedly shorter, its length less than twice its width, in the female of *O. paessleri* (fig. 22B), than in the females of other species, in which its length is greater than or equal to twice its width. *Orobothriurus paeslleri* possesses three pairs of VSM macrosetae on metasomal segment I (fig. 19B), whereas the other species possess two (fig. 19A). The pedipalp chela movable finger of the male is slightly curved in *O. paessleri* (fig. 26B), but strongly curved in the other species (figs. 26C, 43C, 51A). *Orobothriurus paessleri* may be further separated from *O. curvidigitus* and *O. quewerukana* by the shape of the lamina of the hemispermatophore (figs. 28B, C, 40E), the frontal crest of which is shorter and less developed in *O. paessleri* (fig. 28E) than in *O. curvidigitus* and *O. quewerukana* (fig. 28D). Additionally, the ventral surfaces of metasomal segments I–III are finely granular in *O. paessleri* (fig. 19B), whereas only the ventral surfaces of segment

I in males are finely granular in *O. curvidigitus* and *O. quewerukana*.

DISTRIBUTION: *Orobothriurus paessleri* appears to be endemic to the area near Mejía and Yuta (Matarani) in the Arequipa Department of southern Peru (fig. 53). A single record from Toquepala (17°14′S 70°36′W, 3000 m) in the Tacna Department (Maury, 1976), probably based on a misidentification, requires confirmation.

ECOLOGY: As with *O. atiquipa*, this species has only been collected in Lomas biotopes, isolated patches of green vegetation on hillsides below 1000 m, sustained by coastal fog, and surrounded by hyperarid desert. The Lomas vegetation near Mejía and Yuta is dominated by herbaceous shrubs, e.g., *Nolana* L.f., *Palaua* Cav., *Portulaca* L., *Weberbauerella* Ulbr., and the tree *Caesalpinia spinosa* (Molina) Kuntze (Péfaur, 1981; Dávila Flores, 1982).

REMARKS: Specimens of *O. paessleri* from Mejía deposited in the ZMH collection were examined, and found to be misidentified as *O. curvidigitus* by Lourenço and Dastych (2001: 54). Currently two *Orobothriurus* species have been recorded from Lomas formations: *O. atiquipa* and *O. paessleri*. In addition, we examined a single female deposited at MHNC from Lomas de Sama, southern Peru. This specimen is poorly preserved and difficult to identify with certainty.

Orobothriurus parvus Maury, 1976
Figures 4C, 9, 12B, 17A, 22E, 26A, 27B, 52

Orobothriurus parvus Maury, 1976: 17, 21–23, figs. 45–54, table I; Galiano and Maury, 1979: 327; Maury, 1980: 338, fig. 12; Kovařík, 1998: 101; Acosta and Ochoa, 2000: 136, 143; Lowe and Fet, 2000: 36; Acosta and Ochoa, 2001: 205; Lourenço and Dastych, 2001: 54; Ochoa 2004a: 52, 55, 73, table 1, figs. 1, 2, 21.

Bothriurus borellianus Mello-Leitão, 1934: Bücherl, 1959b: 273 [misidentification].

Bothriurus chilensis (Molina, 1782): Aguilar and Meneses, 1970: 3 [misidentification].

Bothriurus (*Andibothriurus*) *peruvianus* Mello-Leitão, 1948: Francke, 1974: 217, 218, figs. 1–5, table 1 [misidentification].

TYPE MATERIAL: **PERU: Junín Department:** *Yauli Province*: Holotype ♂ (MACN-Ar 6837), Abra de Anticona, Oroya [11°36′31″S 76°11′48″W], 4750 m, 28.xi.1974, A. Martínez. Paratypes: same data, 1 ♂, 1 juv. (MACN-Ar 6838); Acaya, Río Mantaro [11°49′S 75°36′W], 3480 m, 1.iii.1957, W. Weyrauch, 1 ♀ (IML 388).

NEW RECORDS: **PERU: Junín Department:** *Jauja Province*: Acolla, near Jauja, [11°44′17″S 75°32′35″W, 3400 m], 8.viii.1953, F. Blancas, 4 ♀, 12 juv. (MUSM), ii.1965, F. Blancas, 2 ♀ (MUSM). *Junín Province*: Ondores [11°04′06″S 76°09′21″W, 4300 m], 6.v.2000, E. Ponce, 2 ♂, 7 ♀ (MHNC); Quebrada Antacocha, between Junín and Carhuamayo [11°03′S 76°00′W, 4090 m], viii.1952, F. Blancas, 1 juv. (MUSM). *Tarma Province:* Tarma, 2 km E [11°24′58″S 75°39′59″W, 3400 m], 4.i.1973, N.F. Hadley and O.F. Francke, 1 ♀ (AMNH). *Yauli Province*: Casaragra?, xi.1947, H. de Madedo, 1 ♀ (MUSM); Cerro Quinan, Tupac Amaru, Yauli, La Oroya [11°32′S 75°54′W, 3968 m], 26.viii.2005, W. Paredes, 1 ♀ (MHNC), 1 juv. (AMNH [LP 6257B]).

DIAGNOSIS: *Orobothriurus parvus* is most closely related to *O. wawita* (fig. 5). Both species share similar hemispermatophore morphology, including an elongated lamina apex and a short frontal crest (fig. 27B, C). The reticulate pigmentation along the metasomal DL carinae (figs. 12B, 13C) and the macrosetal counts on the ventral surface of the metasoma are also similar. The following characters separate the two species. The pedipalp chela manus of the male *O. parvus* possesses an apophysis on the internal surface, and the fixed finger is slightly curved, creating a small gap with the movable finger when the fingers are closed (fig. 26A), whereas the apophysis is absent and the fixed finger straight, such that no gap is evident when the fingers are closed, in the male of *O. wawita* (fig. 25B, C). The VL and VM carinae of metasomal segment V are complete in *O. parvus* (fig. 22E), but absent (♂) or restricted to the distal third of the segment (♀) in *O. wawita* (figs. 21C, 22F). Metasomal segments II–V exhibit a distinct VM pigmentation stripe in *O. parvus* that is absent in *O. wawita* (fig. 13D). The two species also differ in the shape of the ventral margin of the hemispermatophore apex, which is inclined to the dorsal surface and curved distally in *O. parvus* (fig. 27B), but straight in *O. wawita* (fig. 27C).

DISTRIBUTION: *Orobothriurus parvus* is endemic to the central Andes, recorded from

3400–4750 m, in the Junín and Lima departments, Peru (figs. 2E, 52).

ECOLOGY: The area inhabited by *O. parvus* corresponds to the Puna ecoregion or Puna biogeographical province (Brack, 1986; Ceballos Bendezu, 1976). The typical Puna vegetation of this area comprises shrub, steppe, and grasses (fig. 2E). No other scorpion species have been recorded in sympatry with *O. parvus*.

REMARKS: *Orobothriurus parvus* was misidentified in several papers as *Bothriurus borellianus*, *Bothriurus chilensis* or *Bothriurus* (*Andibothriurus*) *peruvianus* (Bücherl, 1959b; Aguilar and Meneses, 1970; Francke, 1974). A record from Colcabamba (Lourenço and Dastych, 2001: 54), based on a single female, requires confirmation.

Orobothriurus quewerukana, n. sp.

Figures 15C, 19C, 20D, 23F, 24D, 40D, E, 41–43, 53; table 3

Orobothriurus dumayi: Maury, 1976: 21, figs. 40–44; Acosta and Ochoa, 2000: 136, 143. [misidentification].

TYPE MATERIAL: **CHILE: Región I (Tarapacá):** *Parinacota Province*: Holotype ♂ (AMNH), Putre, 6 km W, 18°13′26.8″S 69°32′47.1″W, 3732 m, 16.i.2005, A. Ojanguren Affilastro, C.I. Mattoni and J.A. Ochoa, UV and under stones. Paratypes: **CHILE: Región I (Tarapacá):** *Iquique Province*: Termas de Mamiña, 8.viii.1967, J.C. Ortiz, 4 juv. (MACN-Ar 6846); Mamiña, 20°04′33.6″S 69°12′05.4″W, 2822 m, 19.i.2005, A. Ojanguren Affilastro, C.I. Mattoni and J.A. Ochoa, UV and under stones, small wet valley with old terrace cultivation, 2 ♂, 2 ♀, 14 juv. (LBRE), 2 ♂, 2 ♀, 8 juv. (MACN-Ar), 2 ♂, 1 ♀, 1 subad. ♀ (MHNC), 1 ♂, 1 ♀, 6 juv. (MZUC). *Parinacota Province*: same data as holotype, 2 ♂, 2 ♀, 6 juv. (MACN-Ar), 2 ♂, 1 ♀, 3 juv. (LBRE), 1 ♂, 1 ♀, 3 juv. (MHNC), 1 subad. ♂ (AMNH). **PERU: Tacna Department:** *Tacna Province*: Palca, 17°46′45″S 69°57′04″W, 3230 m, 26.ii.2000, J.A. Ochoa, 1 ♀ (AMNH), 1 ♂, 2 ♀ (MHNC).

ADDITIONAL MATERIAL: **CHILE: Región I (Tarapacá):** *Iquique Province*: Mamiña, 20°04′33.6″S 69°12′05.4″W, 2822 m, 19.i.2005, A. Ojanguren Affilastro, C.I. Mattoni, and J.A. Ochoa, UV and under stones, small wet valley with old terrace cultivation, 1 subad. ♂, 1 subad. ♀, 2 juv. ♂, 2 juv. ♀ (AMNH [LP 4307]), 5 juv. (AMNH), 5 juv. (MHNC). *Parinacota Province*: Putre, 6 km W, 18°13′26.8″S 69°32′47.1″W, 3732 m, 16.i.2005, A. Ojanguren Affilastro, C.I. Mattoni and J.A. Ochoa, UV and under stones, 1 subad. ♂, 4 juv. ♂, 1 juv. ♀ (AMNH [LP 4306]), 4 juv. (LBRE), 3 juv. (MHNC).

ETYMOLOGY: The specific name is a noun in apposition composed of two Quechua words, *quewe*, meaning "curved," and *rukana*, meaning "finger." It refers the strong curvature of the movable finger of the pedipalp chela in the adult male.

DIAGNOSIS: *Orobothriurus quewerukana* is closely related to *O. curvidigitus* and *O. tamarugal* (fig. 5), with which it shares the following characters: anterior margin of carapace with weak median projection (epistome; figs. 14C, 15C, D); pedipalp chela shape similar, with movable finger strongly curved in male (figs. 26C, 43C, 51A); pedipalp femur and patella more elongated in male than female; sternite VII with VSM carinae absent or obsolete (fig. 19A, C); metasomal segments I–IV with DL and ML carinae complete, granular, and VL carinae obsolete, smooth. *Orobothriurus quewerukana* may be separated from *O. tamarugal* by the shape of the lamina of the hemispermatophore (figs. 40E, 41D). The pedicel of the apex is narrower, and the frontal crest more developed and elongated in *O. quewerukana*; the ventral border of the distal portion of the apex is slightly curved in *O. quewerukana*, but straight in *O. tamarugal*; and one or two small folds, observed in the distal crest of 80% of the specimens of *O. quewerukana*, are absent in the distal crest of *O. tamarugal*. The hemispermatophore of *O. quewerukana* is similar to that of *O. curvidigitus*, except for the slightly shorter frontal crest and the absence of folds in the distal crest (figs. 28B, 40E). The two species may be distinguished by the shape and granulation of the male telson vesicle, which is slightly deeper, with a length/height ratio of 3.59–4.00 (mean = 3.76), and granulation on the entire ventral surface (fig. 23F), in *O. quewerukana*, compared with *O. curvidigitus*, in which the length/height ratio is 3.72–4.23 (mean = 3.96) and granulation is present only on the

anterior third of the ventral surface. The male pedipalp chela carinae are finely and densely granular in *O. quewerukana* and *O. tamarugal* (figs. 43D, E, 51B, C), but finely and sparsely granular to smooth in *O. curvidigitus*. These species may also be separated by the pigmentation pattern. *Orobothriurus curvidigitus* exhibits well-developed pigmentation on the carapace, tergites, metasoma, and pedipalps (figs. 11B, 12C, 13E), compared to *O. quewerukana* in which the pigmentation, especially that of the carapace and tergites, is faint or barely discernible (fig. 41) and *O. tamarugal*, in which it is absent (fig. 48).

DESCRIPTION: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 38.09–47.00 mm (n = 8, mean = 41.59 mm); ♀, 37.20–51.50 mm (n = 8, mean = 43.35).

Color: General color yellowish with light brown spots on carapace, tergites, and pedipalps; metasomal segments, ventral pigmentation slightly darker, especially in specimens from Palca (fig. 41). Carapace faintly spotted, especially laterally and posteriorly; anterior margin with two spots submedially (fig. 41A, C); posterolateral surfaces faintly pigmented; median ocular tubercle and lateral ocelli dark brown to black; anterior third of anteromedian longitudinal sulcus pigmented along borders; posteromedian longitudinal sulcus faintly pigmented or unpigmented; posterolateral sulci unpigmented. Chelicerae unpigmented. Pedipalp coxa, trochanter and femur usually unpigmented or faintly pigmented along DI and DE carinae (some juveniles); patella external and, usually, internal surfaces faintly spotted; chela unpigmented. Legs, only ventral margin of femur, and dorsal and ventral margins of patella pigmented (unpigmented in some adults). Tergites I–VI each with two faint spots sublaterally, extending along anterior two-thirds, becoming broader near anterior margins, delimiting broad, unpigmented median stripe (fig. 41A, C); VII unpigmented (adults) or with two faint spots sublaterally (juveniles). Sternum, genital opercula, pectines and sternites III–VII unpigmented (fig. 41B, D). Metasomal segments I–III, dorsal surfaces each with two faint subtriangular spots medially, separated by narrow unpigmented line (juveniles) or unpigmented (adults, fig. 41); lateral surfaces unpigmented, except near VL carinae; ventral surface with narrow VM stripe on III (absent on I and II), not contiguous with lateral pigmentation, and two VL stripes on I–III (occasionally faint or absent on I) becoming broader in posterior third; specimens from Mamiña usually less pigmented: VL stripe absent on segments I and II; VM stripe often absent on III. Segment IV, dorsal surface unpigmented; lateral and ventral surfaces as for segment III. Segment V, dorsal surface unpigmented or faintly pigmented posteriorly; lateral surfaces pigmented in distal third; ventral surface with three stripes, two VL and one VM, becoming slightly broader in posterior half but not joining with lateral pigmentation. Telson vesicle unpigmented or with lateral surfaces faintly pigmented; aculeus sclerotized, dark reddish brown.

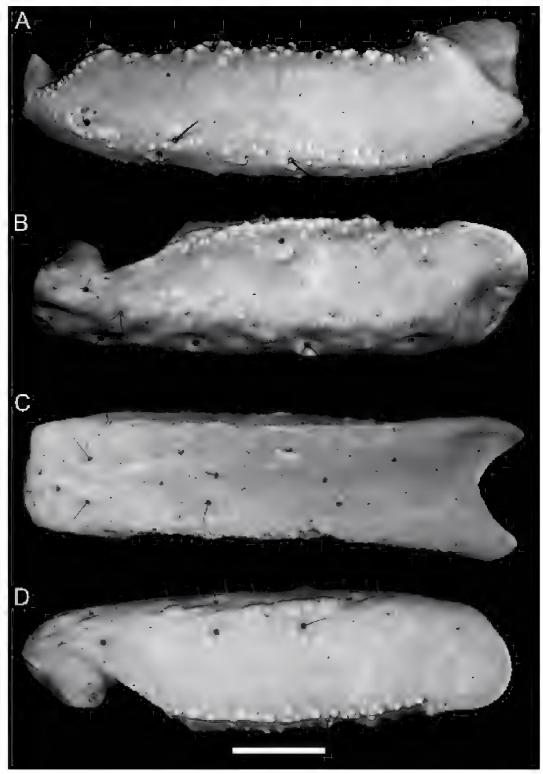

Fig. 49. *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar), dextral pedipalp femur (**A**) and patella (**B–D**). **A, B.** Dorsal aspect. **C.** External aspect. **D.** Ventral aspect. Scale bar = 1 mm.

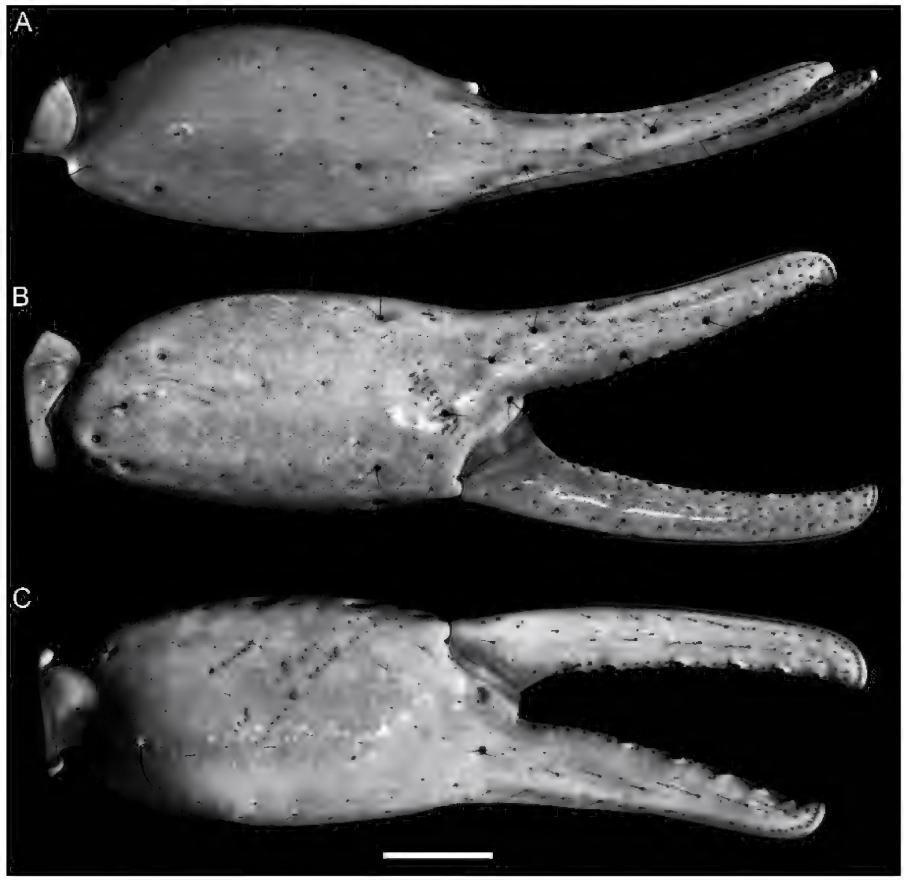

Fig. 50. *Orobothriurus tamarugal*, n. sp., paratype ♀ (MZUC), dextral pedipalp chela. **A.** Dorsal aspect. **B.** External aspect. **C.** Internal aspect. Scale bar = 1 mm.

Chelicerae: Movable finger with two subdistal teeth.

Carapace: Surfaces finely granular, more coarsely so along anterior margin, anteromedian longitudinal and median ocular sulci (♂) or smooth in anterior third, finely granular elsewhere (♀). Anterior margin with weak median projection (epistome; fig. 14C). Anteromedian longitudinal sulcus complete, moderately developed; median ocular and posteromedian longitudinal sulci well developed; posterolateral sulci obsolete. Median ocular tubercle raised, situated anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, DI, DE, and VI carinae complete (fig. 42A), DI carina more strongly developed than DE and VI carinae; VM carina vestigial, finely granular proximally; EM carina complete, granular (♂) or obsolete, finely granular (♀, juveniles); dorsal surface finely granular; internal surface sparsely granular medially. Patella, DI, VI, and VE carinae complete, granular (fig. 42B–D); DE carina complete, less developed than DI carina (♂) or obsolete (♀); EM carina vestigial, reduced to few small granules medially (♂) or absent (♀); DPP carina comprising prominent granule and additional small granules proximally; VPP carina vestigial, comprising two or three small granules proximally; internal surface with prominent granule adjacent to trichobothrium *i* near DI carina. Chela manus slightly rounded, fingers relatively elongated (fig. 43); length/width ratio: ♂, 3.42–4.19, (n = 9, mean = 3.71), ♀, 3.54–4.22 (n = 6, mean = 3.87); length/height ratio: ♂, 2.95–3.32, (n = 9, mean = 3.07), ♀, 2.87–3.34 (n = 6, mean = 3.16); most carinae obsolete, finely granular (less so in ♀) or absent; VM carina restricted

Fig. 51. *Orobothriurus tamarugal*, n. sp., holotype ♂ (MACN-Ar), dextral pedipalp chela. **A.** External aspect. **B.** Ventral aspect. **C.** Ventrointernal aspect. Scale bar = 1 mm.

to proximal two-thirds of manus, VI carina to proximal third; DS, DMA, and DI carinae complete, finely and densely granular, especially near base of fixed finger (♂) or smooth (♀); D carina smooth; internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (fig. 43A, D); movable finger (♂) strongly curved, creating small gap with fixed finger when fingers closed (fig. 43C); fingers, dentate margins each with median denticle row and 4–5 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27 (figs. 42, 43). Chela trichobothrium Et_3 situated proximal to *Est* (in same axis as *Est* in one specimen); *Esb* situated dorsal to Eb_2.

Tergites: Tergites I–VI, surfaces finely granular, more coarsely and densely so in ♂. Tergite VII tetracarinate, paired DL carinae

restricted to posterior two-thirds of segment, paired DSM carinae to posterior half; surfaces more coarsely and densely granular in posterior half.

Legs: Femur and patella, prolateral surfaces finely granular, retrolateral surfaces smooth. Femur, VI and EM carinae complete in ♂, less developed in ♀; DE and DI carinae vestigial. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 20–24 (n = 34, mode = 22); ♀, 19–22 (n = 24, mode = 20).

Sternites: Sternites III–VI, surfaces smooth (♀) or matt in posterior three-quarters (♂); spiracles small, narrow. Sternite VII, surface smooth (♀) or finely granular (♂) (fig. 19C), acarinate.

Metasoma: Segment I, DL carinae complete; ML carinae complete, posterior granules more prominent than adjacent granulation; one pair of ML macrosetae; LIM carinae reduced to few granules in posterior third; VL carinae obsolete; VSM carinae absent (fig. 19C); two pairs of VL and VSM macrosetae. Segments I and II, ventral intercarinal surfaces finely granular (♂). Segments II–IV, surfaces between DL and ML carinae finely and sparsely granular, granulation decreasing posteriorly. Segments II and III, DL carinae complete; one pair of DL macrosetae in 14% and 50% of specimens, respectively; ML carinae as for segment I; LIM carinae reduced to few granules posteriorly on segment II, restricted to posterior third (♂) or absent (♀) on segment III; VL carinae as for segment I but less developed; VSM carinae absent; three pairs of VL and VSM macrosetae. Segment IV, DL carinae complete, granular; one pair of DL macrosetae; ML carinae complete, granular; LIM carinae absent; VL carinae as for segment III (absent in some subadult and juvenile specimens); VSM carinae absent; usually three pairs of VL and VSM macrosetae. Segment V, length/width ratio: ♂, 2.18–2.44 (n = 6, mean = 2.31), ♀, 2.01–2.20 (n = 4, mean = 2.10); DL carinae complete, granular; lateral surfaces sparsely granular near DL carinae (fig. 20D); VL carinae complete; VSM carinae reduced to few granules medially; VM carina complete, obscured by surface granulation in posterior half; usually three pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin; ventral intercarinal surfaces, granulation decreasing anteriorly.

Telson: Length/height ratio: ♂, 3.59–4.00 (n = 9, mean = 3.76); ♀, 2.90–3.17 (n = 6, mean = 3.03). Vesicle slightly elongated (♂, fig. 23F) or globose (♀, fig. 24D); dorsal surface smooth, flat or slightly concave, gland not apparent (♂); ventral surface sparsely granular. Aculeus short and curved.

Hemispermatophore: Apex approximately half the length of lamina, distal border subtriangular and slightly curved to ventral margin; distal crest curved like ventral margin, with one or two small folds in 80% of specimens. Frontal crest elongated; basal part oblique; distal part parallel to ventral margin of lamina, lateral projections complete, slightly undulated, and larger than basal part. Basal lobe, terminal process extending to constriction of frontal crest (fig. 40D, E).

DISTRIBUTION: *Orobothriurus quewerukana* is endemic to the western slopes of the Andes, at 2822–3732 m, in the Tacna Department of southern Peru and the Tarapacá Region of northern Chile (fig. 53).

ECOLOGY: The area inhabited by *O. quewerukana* belongs to the Serrania Esteparia ecoregion (Brack, 1986) or Estepa Altoandina botanical region (Gajardo, 1993), the vegetation of which is characterised by abundant cacti and some shrubs, like *Baccharis* L., *Lupinus* L., and *Senecio* L. Specimens were collected under stones during the day and with UV light detection at night. *Orobothriurus quewerukana* is sympatric with another bothriurid, *Brachistosternus quiscapata* Ochoa and Acosta, 2002, at Palca and Putre.

Orobothriurus ramirezi, n. sp.

Figures 16A, B, 18C, 20C, F, 21G, 24E, 44–46, 47A, B, 54; table 3

TYPE MATERIAL: **CHILE: Region IV (Coquimbo):** *Elqui Province*: Holotype ♂ (MACN-Ar), Paso del Agua Negra, between Juntas and international border, 30°12′11.5″S 69°54′57.5″W, 3734 m, 27.i.2005, C.I. Mat-

toni and A. Ojanguren Affilastro, UV detection, specimens walking actively near a "vega" (small stream), extremely wet. Paratypes: same data, 4 ♂, 1 ♀ (AMNH), 2 ♂, 1 ♀ (LBRE), 1 ♂, 1 ♀ (MACN-Ar), 1 ♂ (MHNC); same data, except 30°16′14.5″S 69°58′27.9″W, 3295 m, 1 ♂, 1 ♀, 5 juv. (AMNH), 1 ♀, 2 subad. ♂ (AMNH [LP 4305]), 1 ♂, 1 ♀, 3 juv. (LBRE), 1 ♂, 1 ♀, 2 juv. (MACN-Ar), 1 ♀, 2 juv. (MHNC), 1 ♂, 2 juv. (MZUC).

Additional Material: **CHILE: Region IV (Coquimbo):** *Elqui Province*: Mine El Indio, Cancha Sky base camp [29°51′38″S 70°02′12″W, 3225 m], v.1996, H. Vásquez C., pitfall trap, 1 ♀, 1 juv. (ULS); Mine El Indio, Mangueras, ca. 4000 m, 1 juv. (AMNH), 1 juv. (LBRE); Mine El Indio, Pastos Largos [29°49′S 70°03′W, 3600 m], i.1995, H. Vásquez C., pitfall trap, 1 ♀, 1 juv. (ULS), 6.xi.2003, L. Prendini, C.I. Mattoni and J.A. Ochoa, UV detection, very cold and windy, full moon, alpine vegetation on scree slope near small stream, specimen sitting in open ground, 1 subad. (AMNH [LP 2402]); Mine El Indio, Quebrada El Negro [29°47′06″S 70°00′00″W, 3808 m], 6.xi.2003, C.I. Mattoni, L. Prendini, and J.A. Ochoa, UV detection and diurnal rock rolling, puna vegetation, low bushes and grass tufts, hard, rocky ground with bare patches, stones in places, at night, very cold and windy, full moon, specimens on rocky slope (juv. under stone), 1 ♀, 1 juv. (AMNH [LP 2401]); Mine El Indio, Tambo [29°48′S 69°58′W, 4030 m], ii.1997, H. Vásquez C., pitfall trap, 1 ♂, 1 ♀, 1 juv. (ULS); Paso del Agua Negra, between Juntas and international border, 30°12′11.5″S 69°54′57.5″W, 3350 m, 6.iii.2006, A. Ojanguren Affilastro, L. Compagnucci, and C. Cuezzo, UV detection, 1 ♂, 1 ♀, 1 subad. ♀, 1 juv. (MACN-Ar).

Etymology: This species is named in honor of the Argentine arachnologist Martín J. Ramírez (MACN) for his contributions on the biodiversity and systematics of South American arachnids.

Diagnosis: *Orobothriurus ramirezi* is closely related to *O. alticola* (fig. 5), based on similar pigmentation pattern, metasomal carination, and hemispermatophore morphology. The two species may be separated by the distal crest of the hemispermatophore, which is comparatively more developed, occupying almost the entire apex of the lamina, in *O. ramirezi*, than in *O. alticola*, in which it occupies only half the apex (figs. 36I, J, 47A, B). The telson vesicle of *O. ramirezi* is more rounded, especially in females (telson length/width ratio: ♂, 2.65–2.94, mean = 2.78; ♀, 2.13–2.37, mean = 2.27; figs. 23G, 24E) than that of *O. alticola* (telson length/width ratio: ♂, 2.87–3.21, mean = 3.07; ♀, 2.44–2.55, mean = 2.49; fig. 23A). The dorsal surface of the femur and ventral surface of the metasoma are more pigmented, with broader stripes, in *O. ramirezi* than *O. alticola*. The metasomal carinae, especially the VL and VSM carinae of segments I and V, and the DL carinae of segment V, are more developed in males of *O. ramirezi* than *O. alticola* (fig. 20A, C).

Description: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 27.3–36.0 mm (n = 13, mean = 31.6 mm); ♀, up to 37.8 mm.

Color: General color yellowish with dark brown spots. Carapace, anterior margin unpigmented (fig. 44A, C); lateral margins with two spots laterally and two smaller spots posterolaterally, intermediate area with faint reticulate pigmentation; median ocular tubercle and lateral ocelli dark brown or black; posterior half of anteromedian longitudinal sulcus, median ocular tubercle, and posteromedian longitudinal sulcus pigmented. Chelicerae unpigmented. Pedipalp coxa unpigmented; trochanter, dorsal and lateral surfaces faintly pigmented; femur, ventral surface unpigmented, dorsal surface pigmented, except for oval unpigmented area, occupying up to two-thirds of segment distally; internal and external surfaces unpigmented, except for faint stripes along VL and VI carinae; chela manus with six complete longitudinal stripes along carinae, joining at base of movable finger; fingers unpigmented except basally. Legs, coxa and trochanter unpigmented; femur, dorsal and prolateral surfaces sparsely spotted, spots becoming larger near articulation with patella; patella, prolateral, dorsal and ventral surfaces sparsely pigmented; basitarsi and telotarsi, dorsal and prolateral surfaces faintly spotted. Tergites I–VI each with two faint spots sublaterally, reaching pretergites on III–VI and delimiting unpig-

mented median stripe; VII with two small, faint, spots of pigmentation submedially (fig. 44A, C). Sternum, genital opercula, pectines, and sternites III–VI unpigmented; sternite VII with two, often faint, spots sublaterally. Metasomal segment I, dorsal surfaces each with faint subtriangular spot medially; lateral surfaces pigmented between ML and LIM carinae; ventral surface with two narrow VL stripes becoming slightly broader in posterior half (fig. 44). Segments II–IV, dorsal surfaces each with small subtriangular spot medially; lateral surfaces densely pigmented below ML carinae; ventral surfaces each with three separate, narrow stripes (one VM and two VL), becoming broader in posterior half. Segment V, dorsal surface unpigmented; lateral surfaces with weak reticulate pigmentation; ventral surface with three separate stripes (one VM and two VL), becoming broader posteriorly. Telson vesicle, dorsal surface unpigmented (♀) or with faint longitudinal stripe (♂); ventral surface with three broad dark stripes (two VL and one VM), separated by two narrow unpigmented stripes; aculeus sclerotized, dark reddish brown.

Chelicerae: Movable finger with two subdistal teeth.

Carapace: Median surfaces smooth; lateral margins finely granular, less so in ♀. Anterior margin linear, without median notch (fig. 16A, B). Anteromedian longitudinal sulcus obsolete; median ocular, posteromedian longitudinal and posterolateral sulci well developed. Median ocular tubercle raised, situated anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, DI and VI carinae complete, finely granular; DE carina obsolete, smooth (fig. 38A); internal surface finely and sparsely granular medially; other intercarinal surfaces smooth. Patella, DI and VI carinae obsolete, finely granular (♂) or smooth (♀) (fig. 38B–D); internal surface with two prominent granules distally, the larger adjacent to trichobothrium *i*; other intercarinal surfaces smooth.

Pedipalps: Femur, DI and VI carinae complete, granular (fig. 45A); DE carina complete, granular in distal third to distal half of segment, other carinae smooth; ventral surface sparsely granular, more densely granular in proximal half. Patella, DI and VI carinae complete, granular, less so in ♀ (fig. 45B–D); DPP carina comprising small granules proximally; VPP carina absent; internal surface coarsely granular with prominent granule adjacent to trichobothrium *i* near DI carinae; other surfaces smooth. Chela manus slender, fingers relatively elongated (fig. 46); length/width ratio: ♂, 3.58–4.14 (n = 12; mean = 3.84), ♀, 3.31–3.9 (n = 6, mean = 3.62); length/height ratio: ♂, 2.94–3.75 (n = 12; mean = 3.3), ♀, 3.06–3.4 (n = 6, mean = 3.29); DMA, DI, and VM carinae obsolete, other carinae absent; intercarinal surfaces smooth; internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (fig. 46A, D); fingers, dentate margins each with median denticle row and 4–5 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27. Chela trichobothrium Et_3 situated proximal to *Est* (fig. 46).

Tergites: Tergites I–VI, surfaces finely granular (♂) or smooth (♀). Tergite VII tetracarinate, paired DL carinae restricted to posterior two-thirds of segment, paired DSM carinae to posterior half; intercarinal surfaces coarsely granular, other surfaces finely granular.

Legs: Femur and patella, prolateral surfaces finely granular, retroventral surfaces smooth. Femur, ventral carinae weakly developed; other carinae absent. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 21–26 (n = 33, median = 23); ♀, 15–20 (n = 34, median = 18).

Sternites: Sternites III–VI, surfaces smooth (♀) or finely corrugated (♂), especially in posterior half; spiracles small, narrow. Sternite VII, surface smooth; VL and VSM carinae obsolete (fig. 18C).

Metasoma: Segment I, DL carinae complete, moderately granular; ML carinae complete, moderately granular in posterior two-thirds; one pair of ML macrosetae; LIM carinae complete, moderately granular in posterior half; VL and VSM carinae well developed (especially in ♀, fig. 19C), com-

plete, granular; two pairs of VSM and VL macrosetae. Segment II, DL carinae complete, granular; ML carinae complete, granular; one pair of ML macrosetae; LIM carinae restricted to the posterior third; VSM and VL carinae well developed, complete (♀, fig. 18C) or obsolete (♂); usually two pairs of VL and three pairs of VSM macrosetae. Segment III, DL and ML carinae complete, moderately granular; one pair of ML macrosetae; LIM carinae reduced to two or three granules in posterior quarter; VL and VSM carinae obsolete; two or three pairs of VL and three pairs of VSM macrosetae. Segment IV, DL carinae complete, granular; one pair of DL macrosetae; ML carina reduced to few distal granules (♀) or obsolete (♂); one or two pairs of ML macrosetae; LIM, VL and VSM carinae absent; three pairs of VL and three or four pairs of VSM macrosetae. Segment V, length/width ratio, ♂, 2.29–2.69 (n = 12; mean = 2.44), ♀, 1.9–2.2 (n = 6; mean = 2.02); DL carinae complete, more evident in anterior half; lateral margin smooth; ML carinae absent; four pairs of ML macrosetae; VL carinae complete (♂) or restricted to posterior three-quarters (♀); VL and VSM carinae situated close together, fused in posterior third; VM carina complete, obscured by surface granulation in posterior half (fig. 20C); four pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin.

Telson: Length/width ratio: ♂, 2.65–2.94 (n = 13, mean = 2.78); ♀, 2.13–2.37 (n = 10, mean = 2.27). Length/height ratio: ♂, 3.33–3.89 (n = 13, mean = 3.53); ♀, 2.63–3 (n = 10, mean = 2.86). Vesicle elongated (♂, fig. 23G, 24G) or globose (♀, fig. 24E); dorsal surface smooth, slightly concave, gland not apparent (♂); ventral surface smooth (♂) or granular (♀). Aculeus short and curved, more so in ♀.

Hemispermatophore: Apex very well developed; distal crest very well developed, occupying almost three quarters of apex, curved like ventral margin. Frontal crest weakly developed, less than half length of lamina; basal part oblique; distal part short, parallel to ventral margin of lamina, slightly undulated. Basal lobe, terminal process extending almost to constriction of frontal crest (fig. 47A, B).

DISTRIBUTION: *Orobothriurus ramirezi* is known only from localities above 3200 m in the Cordillera de Doña Ana of the Andes, in the Elqui Province of Region IV (Coquimbo), Chile (fig. 54).

ECOLOGY: Most specimens were collected near wetland ecosystems termed "vega" or "humedal" (Squeo et al., 1994; Cepeda-Pizarro, 2004) in the high Andes. These habitats are characterized by an accumulation of water resulting in permanently flooded soil. The temperature at 3750 m varies from −17 °C in winter, to more than 24 °C in summer, but temperatures below zero are possible throughout the year (Cepeda-Pizarro, 2004). Precipitation in the form of snow, which may accumulate up to 8 m in some areas, occurs mainly during winter. The vegetation corresponds to a steppe with diverse altitudinal levels: shrub steppe (or sub-Andean floor) at 2700–3500 m, subshrub steppe at 3500–4250 m, and high-Andean steppe at 4250–4450 m, above which there is no vegetation (Squeo et al., 1994; Cepeda-Pizarro, 2004). *Orobothriurus ramirezi* has not been found in the upper altitudinal level, where the "vega" ecosystem is absent. It is sympatric with another bothriurid, *Brachistosternus perettii* Ojanguren Affilastro and Mattoni, 2006, that apparently prefers rocky areas (Ojanguren Affilastro and Mattoni, 2006). The most closely related species, *O. alticola*, inhabits similar habitats on the western side of the Andes. Despite the proximity of the nearest locality of *O. alticola* (only 16 km as the crow flies), the two species are allopatric, separated by the highest peaks of the Andes, the lowest pass being 4700 m, where life is almost absent. Most adult males of *O. ramirezi* were collected at night with UV light detection, sitting or walking near streams, probably in search of females, suggesting that the period when they where collected (late January, midsummer in the Southern Hemisphere) is the active season for this species.

Orobothriurus tamarugal, n. sp.

Figures 15D, 19F, 20E, 21H, 24F, 47C, D, 48–51, 53; table 3

TYPE MATERIAL: **CHILE: Region I (Tarapacá):** *Iquique Province*: Holotype ♂

(MACN-Ar), La Tirana, 2 km W, 20°19′59.8″S 69°40′07.6″W, 999 m, 18.i.2005, A. Ojanguren Affilastro, C. Mattoni and J.A. Ochoa, UV sampling in *Prosopis tamarugo* forest. Paratypes: Pampa del Tamarugal National Park, Salar de Pintados (salt lake), near rangers' office and campsite, 20°26′16.1″S 69°45′55.2″W, 1014 m, 18.i.2005, A. Ojanguren Affilastro, C. Mattoni, and J.A. Ochoa, UV sampling in *Prosopis tamarugo* forest and under salt plates, 1 ♂ (AMNH), 1 ♀ (MZUC), 1 juv. (LBRE).

ADDITIONAL MATERIAL: **CHILE: Region I (Tarapacá):** *Iquique Province*: Pampa del Tamarugal National Park, Salar de Pintados (salt lake), near rangers' office and campsite, 20°26′16.1″S 69°45′55.2″W, 1014 m, 18.i.2005, A. Ojanguren Affilastro, C. Mattoni, and J.A. Ochoa, UV sampling on *Prosopis tamarugo* forest and under salt plates, 1 ♀, 4 juv. (AMNH [LP 4308]).

ETYMOLOGY: The specific name is a noun in apposition referring to the Pampa del Tamarugal, where this species was collected.

DIAGNOSIS: *Orobothriurus tamarugal* is most closely related to *O. curvidigitus*, *O. paessleri*, and *O. quewerukana* (fig. 5). The carapace possesses a median projection (epistome) at the anterior margin, and a marked anteromedian longitudinal sulcus (figs. 14C, 15C, D), and the males exhibit a curved movable finger on the pedipalp chela (fig. 51A) and a more elongated femur and patella than the females, in all four species. These species may be separated by the shape of the lamina of the hemispermatophore. The frontal crest is more developed and elongated, and the pedicel of the apex narrower in *O. curvidigitus* and *O. quewerukana* (figs. 28B, 40E) than in *O. paessleri* and *O. tamarugal* (figs. 28C, D, 47D). Most specimens of *O. quewerukana* possess one or two small folds in the distal crest (fig. 40E), which are absent in *O. curvidigitus*, *O. paessleri*, and *O. tamarugal* (figs. 28A, B, 47D). Additionally, the ventral border of the distal portion of the apex is straight in *O. tamarugal*, but slightly curved in *O. quewerukana*. The metasomal carinae of *O. curvidigitus*, *O. quewerukana*, and *O. tamarugal* are similarly developed: the DL and ML carinae are complete and granular on segments I–IV, the VL carinae obsolete and smooth on I–IV, and the VSM carinae almost completely fused with the VL carinae on V. *Orobothriurus tamarugal* can be separated from *O. curvidigitus*, *O. paessleri*, and *O. quewerukana* by the near complete absence of pigmentation, which is present on the carapace, tergites, and ventral surfaces of the metasoma in the other species. The carinae of the pedipalp femur are less developed in *O. tamarugal*: the DE carinae, in particular, are incomplete in *O. tamarugal* (fig. 49A), but complete and comprising larger granules in *O. curvidigitus* and *O. quewerukana* (fig. 42A). The IM carina of the male pedipalp chela is present and finely granular in *O. tamarugal*, but absent in *O. curvidigitus* and *O. quewerukana*. The ventral surfaces of sternite VII and metasomal segment I are densely granular in *O. tamarugal* (fig. 19F), finely granular to smooth in *O. quewerukana* (fig. 19C), and entirely smooth in *O. curvidigitus* (fig. 19A).

DESCRIPTION: Based on holotype ♂ and paratypes. Measurements of holotype ♂ and paratype ♀ recorded in table 3.

Total length: ♂, 23.5–35.3 mm ($n = 2$); ♀, 30.1 mm ($n = 1$).

Color: General color yellowish, with faint dark brown spots. Carapace almost unpigmented (adults), except for median ocular tubercle and lateral ocelli (fig. 48) or faintly pigmented (juveniles), one spot near anterior margin, two spots median laterally and two faint spots posterolaterally, with median ocular tubercle, lateral ocelli, anteriomedian and posteriomedian longitudinal sulci more densely pigmented. Tergites almost unpigmented, except for two large faint spots laterally, delimiting broad, unpigmented median band (fig. 48). Chelicerae, pedipalps, legs, sternum, genital operculum, pectines, sternites, metasoma, and telson unpigmented; aculeus sclerotized, dark reddish brown.

Chelicerae: Movable finger with two subdistal teeth, very small in ♂.

Carapace: Anterior margin granular (♂) or smooth (♀); anteromedian surfaces smooth; lateral margins finely granular, more so in ♂. Anterior margin linear (♀, juv.) or with small median projection (epistome) (♂, fig. 15D). Anteromedian longitudinal, median ocular, and posteromedian sulci well developed; posterolateral sulci obsolete. Median ocular tubercle raised, situated

anteromedially; median ocelli two ocular diameters apart.

Pedipalps: Femur, more elongated in ♂, length/width ratio: ♂, 4.05–4.27 (n = 2), ♀, 3.13; DI and VI carinae complete, granular; DE carina almost complete, coarsely granular in proximal three-quarters, smooth elsewhere; internal surface sparsely and coarsely granular (fig. 49A). Patella, more elongated in ♂, length/width ratio: ♂, 3.45–4.10 (n = 2), ♀, 2.95; DI and VI carinae almost complete, granular (fig. 49B–D); DE and VE carinae vestigial, finely and sparsely granular in ♂; internal surface sparsely granular, with prominent granule adjacent to trichobothrium *i* near DI carina. Chela manus slightly rounded, fingers relatively elongated (figs. 49, 50); length/width ratio: ♂, 3.18–4.07 (n = 2), ♀, 3.83; length/height ratio: ♂, 2.90–3.62 (n = 2), ♀, 3.83; carinae obsolete, finely granular (less so in ♀) or absent; VM carina restricted to proximal three-quarters of manus; DS, DMA, DI carinae complete, finely and densely granular (♂) or smooth (♀); D carina finely and sparsely granular; IM carina finely and sparsely granular in proximal half (fig. 51B); intercarinal surfaces finely granular (♂, fig. 51) or smooth (♀, fig. 50); internal surface with acuminate apophysis (♂) or low bulge (♀) near articulation of movable finger (♀) (figs. 50A, 51B); movable finger (♂), strongly curved, creating small gap with fixed finger when fingers closed (fig. 51A); fingers, dentate margins each with median denticle row and 5–6 pairs of internal and external accessory denticles.

Trichobothria: Femur with 3 trichobothria, patella with 19, chela with 27 (figs. 49–51). Chela trichobothrium Et_3 situated in same axis as, or slightly basal to *Est* (figs. 50, 51).

Tergites: Tergites I–VI, surfaces finely granular, more coarsely and densely so near distal margins of III–VI (♂) or smooth (♀). Tergite VII tetracarinate, paired DL carinae restricted to posterior two-thirds of segment, paired DSM carinae to posterior third; intercarinal surfaces granular.

Legs: Femur and patella, prolateral surfaces finely granular, retrolateral surfaces smooth. Femur, ventral carinae weakly developed; other carinae absent. Patella acarinate. Telotarsi, pro- and retroventral rows of spiniform macrosetae with following counts on leg I, 1/1; II, 2/2; III and IV, 3/3.

Pectines: Pectinal tooth count: ♂, 19–21 (n = 6; mode = 20); ♀, 17–18 (n = 2).

Sternites: Sternites III–VI, surfaces smooth; spiracles small, elliptical, and narrow. Sternite VII, surface smooth in anterior half, sparsely granular in posterior half; VL carinae obsolete, slightly more developed in holotype ♂ (fig. 19F); VSM carinae absent.

Metasoma: Segment I, DL carinae complete, moderately to coarsely granular; ML carinae well developed, becoming more coarsely granular in posterior two-thirds; LIM carinae moderately to coarsely granular, restricted to posterior two-thirds, oriented obliquely to antero-dorsal surface, almost joining ML carinae; one pair of macrosetae situated medially between ML and LIM carinae; VL carinae complete, obsolete, finely granular; VSM carinae weakly developed, sparsely granular; two pairs of VSM and VL macrosetae (fig. 19F). Segments II–IV, DL carinae complete, coarsely granular; one pair of DL macrosetae; ML carinae complete, coarsely granular; one pair of ML macrosetae; surfaces between ML and LIM carinae granular on segments II and III; LIM carinae reduced to few granules in posterior third of segment II, less developed on III, absent on IV; VL carinae vestigial, becoming absent toward segment IV; VSM absent or reduced to few scattered granules on segment II (♀); three pairs of VL and VSM macrosetae. Segment V, length/width ratio, ♂, 1.95–2.24, ♀, 1.86; DL carinae reduced to few granules in anterior half; one pair of DL macrosetae; ML carinae obsolete, granular; two pairs of ML macrosetae; lateral intercarinal surfaces finely and sparsely granular; VL and VM carinae complete, granular; VL and VSM carinae fused, only separated medially (fig. 20E); ventral intercarinal surfaces granular; three pairs of VL and VSM macrosetae; two pairs of macrosetae along posterior margin.

Telson: Length/height ratio: ♂, 2.53–3.06 (n = 2); ♀, 2.3 (n = 1). Vesicle elongated (♂, fig. 22H) or oval (♀, fig. 24F); dorsal surface smooth, slightly concave medially, gland not apparent (♂); ventral surface coarsely granular. Aculeus short and curved, more so in ♀.

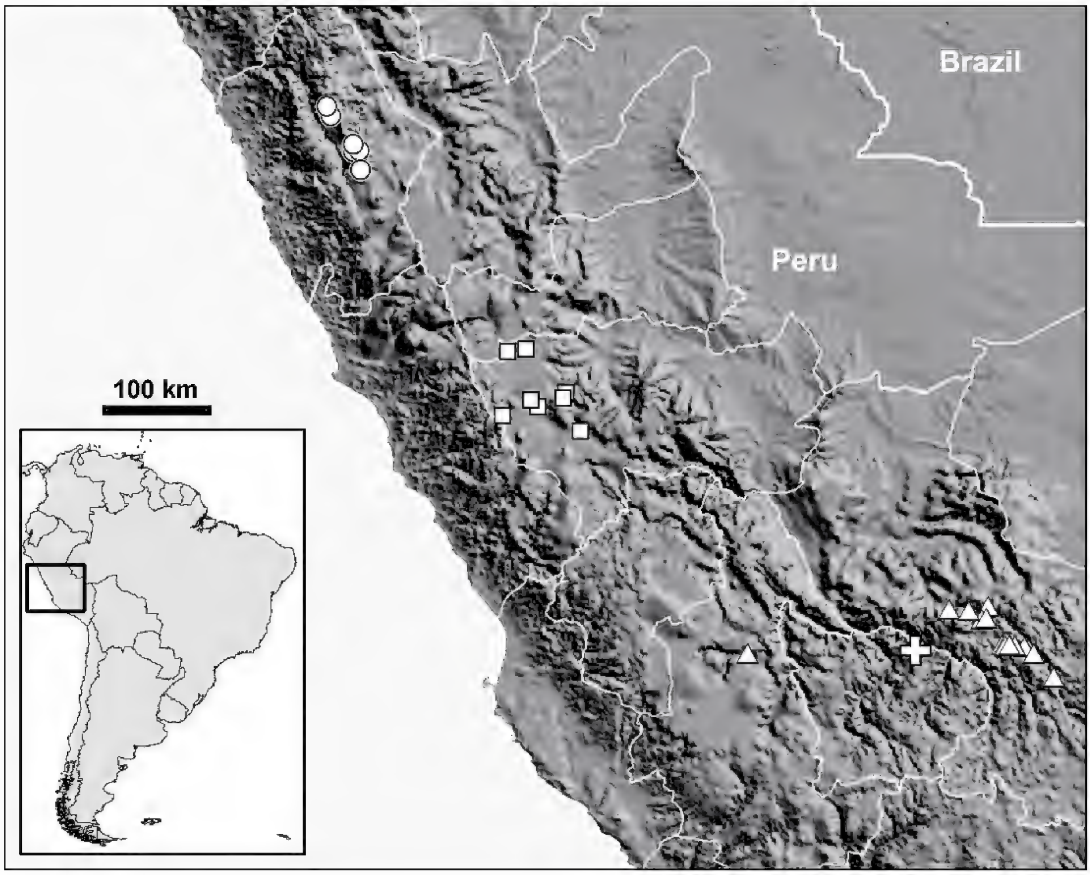

Fig. 52. *Orobothriurus* Maury, 1976, locality records in central Peru. *Orobothriurus ampay* Ochoa and Acosta, 2003, cross; *Orobothriurus huascaran*, n. sp., circles; *Orobothriurus parvus* Maury, 1976, squares; *Orobothriurus wawita* Acosta and Ochoa, 2000, triangles.

Hemispermatophore: Apex very well developed; distal crest almost straight, well developed, restricted to distal half of apex. Frontal crest weakly developed, less than half length of lamina; basal part oblique; distal part short, parallel to ventral margin of lamina, lateral projections slightly undulated with minute granulation. Basal lobe, terminal process extending almost to median part of frontal crest (fig. 47C, D).

DISTRIBUTION: All known records of this species are located in the Pampa del Tamarugal of Iquique Province, Region I (Tarapacá), Chile (figs. 3A, 53).

ECOLOGY: The Pampa del Tamarugal is a desert area characterized by the near absence of rainfall (0.2–1 mm per year), high-salinity soils (mostly of alluvial origin from the Andes), depressions with salt lakes, and a forest dominated by *Prosopis tamarugo* and *Prosopis chilensis* (Mol.) Stuntz trees (fig. 3A). *Prosopis tamarugo* is a deciduous open-crowned tree up to 18 m tall, with a trunk up to 80 cm in diameter, a dense mat of lateral roots and a deep taproot (up to 6 m deep on trees 15 m tall; Habit et al., 1981; Serra, 1997). Temperatures in the Pampa del Tamarugal vary from −12 °C during winter nights to 36 °C on summer days, with a daily range of more than 35 °C in summer. The salt lakes are dry, surface water is absent year-round, and the groundwater may be more than 60 m below the surface. The only humidity is provided by sporadic fog. *Prosopis tamarugo* forests occur only where groundwater is between 2–40 m below the surface (Serra, 1997). Specimens of *O. tamarugal* were collected at night, with UV light detection, inside the forest. The two

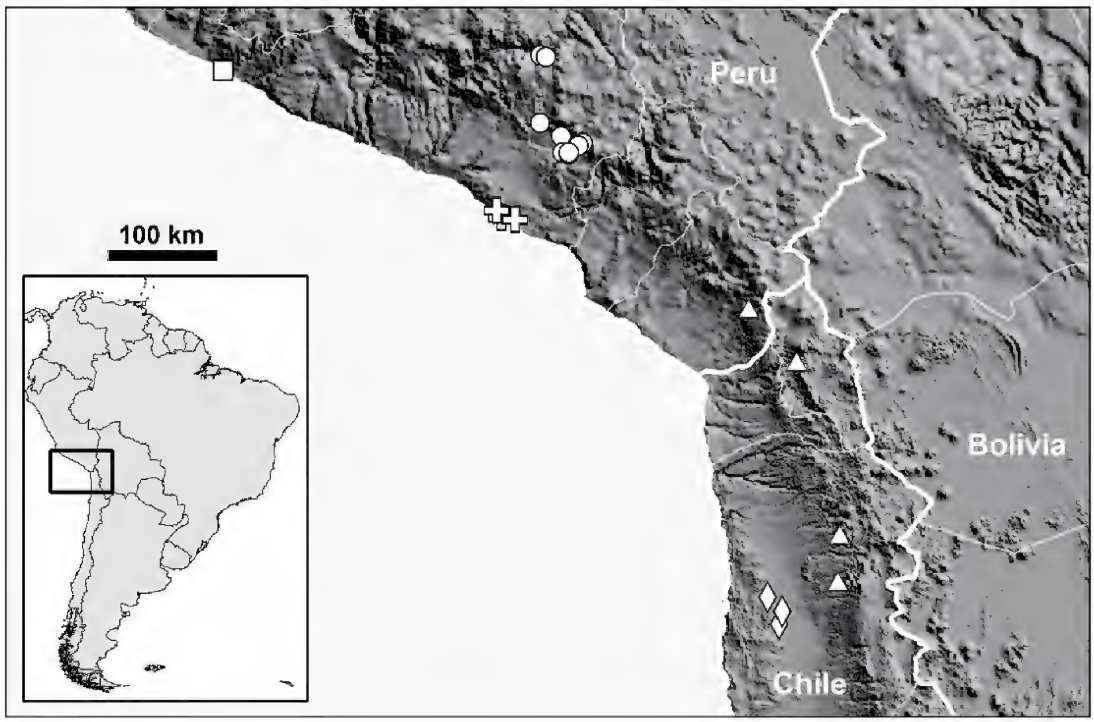

Fig. 53. *Orobothriurus* Maury, 1976, locality records in southern Peru and northern Chile. *Orobothriurus atiquipa* Ochoa and Acosta, 2002, square; *Orobothriurus curvidigitus* (Kraepelin, 1911), circles; *Orobothriurus paessleri* (Kraepelin, 1911), crosses; *Orobothriurus quewerukana*, n. sp., triangles; *Orobothriurus tamarugal*, n. sp., diamonds.

males collected were active on the surface, sitting below large trees. The females and juveniles were inactive, resting under large plates of hard soil and salt (one of the forests is located near a dry salt lake). *Brachistosternus donosoi* Cekalovic, 1974, a larger and more active bothriurid species, was collected in sympatry.

Orobothriurus wawita
Acosta and Ochoa, 2000
Figures 13C, D, 16C, D, 19E, 21C, 22F, 25B, C, 27C, 52

Orobothriurus wawita Acosta and Ochoa, 2000: 137–143, figs. 1–13; 2001: 205; 2002: 18; Ochoa, 2004a: 43, 52, 55, 73, figs. 1, 2, 21, table 1; 2005: 55, 56, figs. 7, 9, table 2; Rein, 2007: 5.

TYPE MATERIAL: **PERU: Cusco Department:** *Urubamba Province*: Holotype ♂ (MACN-Ar 9652), Pacchac, Pumahuanca, 13°13′S 72°06′W, 3800 m, 17.vii.1998, J.A. Ochoa. Paratypes: **Cusco Department:** *Urubamba Province*: same data as holotype, 1 ♂, 1 ♀ (CDA 019); same locality as holotype, 23.vii.1998, J. Flores and J.A. Ochoa, 2 ♂, 2 ♀ (MHNC), 1 ♀ (MACN-Ar 9653); Maras [13°19′53″S 72°09′22″W, 3360 m], 29.x.1997, O. Mujica and J.A. Ochoa, 1 ♂ (MHNC). **Ayacucho Department:** *Cangallo Province*: Común Pampa [13°37′S 74°08′W, 2700 m], 10.ii.1963, R. Garcia, 2 ♀ (MUSM).

NEW RECORDS: **PERU: Cusco Department:** *Quispicanchis Province*: Lucre, Huacarpay [13°36′30″S 71°44′03″W], ca. 3000 m, 14.i.2004, J.A. Ochoa, 2 juv. (AMNH [LP 3059]). *Urubamba Province*: Ollantaytambo [13°15′18″S 72°15′46″W, 2861 m], 14.iii.1947, J.C. Palhsler, 1 ♀ (MACN-Ar), 13.ii.1983, S. and A. Roig, 1 ♀ (MACN-Ar); Ollantaytambo, Río Kusichaca (Inka trail) [13°14′45″S 72°25′46″W], 2750 m, 15.i.1983, S. and A. Roig, 1 ♀ (MACN-Ar).

DIAGNOSIS: *Orobothriurus wawita* may be distinguished from other species of the genus by the following characters. This species lacks an apophysis on the internal surface of the pedipalp chela manus of the male

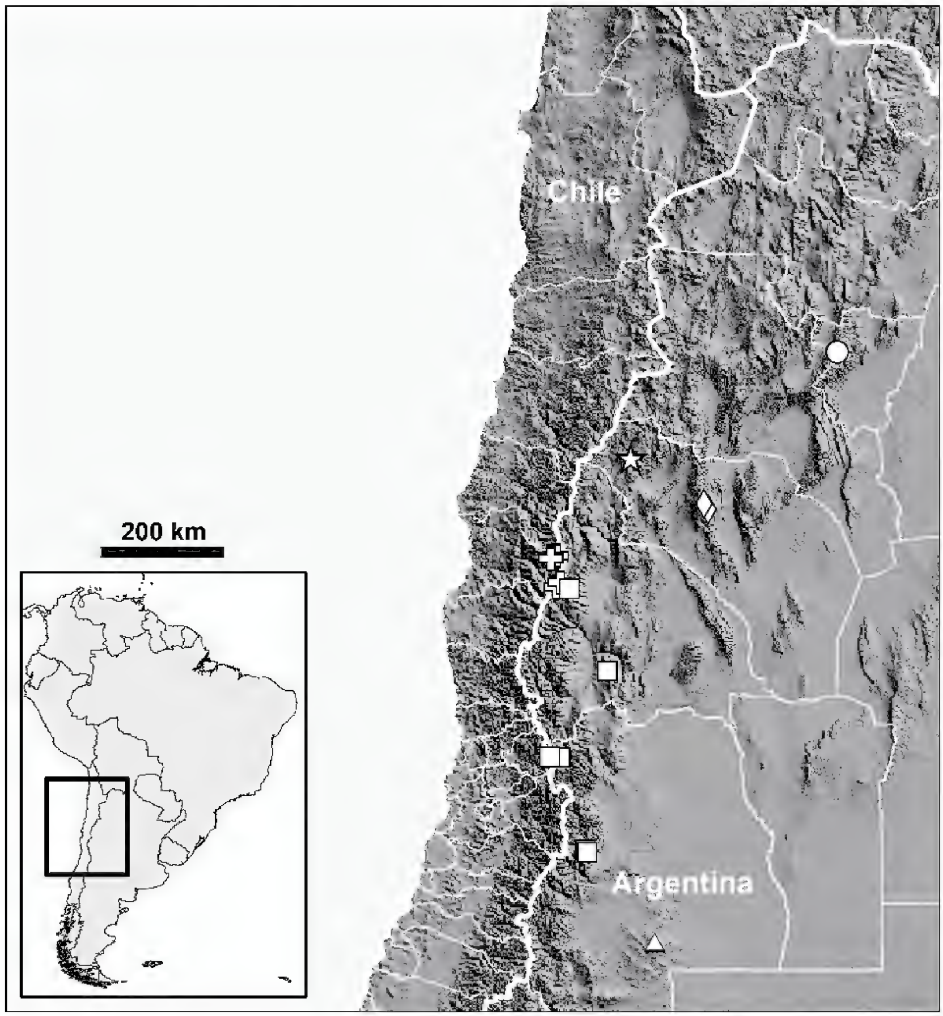

Fig. 54. *Orobothriurus* Maury, 1976, locality records in Argentina and central-northern Chile. *Orobothriurus alticola* (Pocock, 1899), squares; *Orobothriurus calchaqui*, n. sp., circle; *Orobothriurus compagnuccii*, n. sp., star; *Orobothriurus famatina* Acosta, 2001, diamonds; *Orobothriurus grismadoi* Ojanguren Affilastro et al., 2009, triangle; *Orobothriurus ramirezi*, n. sp., crosses.

(fig. 25C), which is present in all other species except *O. ampay*, in which it is reduced to vestigial granules. The pedipalp chela manus of *O. wawita* is slender (fig. 23B, C) with a greater length/width ratio, 5.6–6.5 (♂), 4.46–5.45 (♀), than all other species, 2.98–4.6 (♂), 3.2–4.22 (♀). The pigmentation on the ventral surfaces of the metasoma of *O. wawita* comprises irregular scattered spots, not forming a VM stripe (fig. 13D) that is present and well defined, at least on metasomal segments II–IV, in other species (figs. 11, 13A). *Orobothriurus wawita* is most closely related to *O. parvus* (fig. 5). Both species share similar reticulate pigmentation along the metasomal DL carinae (figs. 12B, 13C), macrosetal counts on the ventral surfaces of the metasoma, and hemispermatophore morphology, including an elongated lamina apex and a short frontal crest (figs. 27B, C). These two species may be distinguished by the following characters. The fixed finger of the pedipalp chela of the male is straight, such that no gap is evident when the fingers are closed, in *O. wawita* (fig. 25B, C), whereas it is slightly curved, creating a small gap when the fingers are closed, in *O. parvus* (fig. 26A). The VL and VM carinae of metasomal

segment V are absent (♂) or restricted to the distal third of the segment (♀) in *O. wawita* (figs. 21C, 22F), but complete in *O. parvus* (fig. 22E). The ventral margin of the apex of the hemispermatophore is straight in *O. wawita* (fig. 27C), but curved distally to the dorsal surface in *O. parvus* (fig. 27B).

DISTRIBUTION: All except one record of this species are situated in inter-Andean valleys at 2700–3800 m in the Ayacucho and Cusco departments of southern Peru (figs. 2B, C, 52). A record from Potosi (19°34′S 65°28′W), 900 km from Cusco in Bolivia (fig. 1), is based on a single female, which, although morphologically similar to Peruvian material, possesses slight differences in pigmentation pattern and granulation of the metasomal segments (Acosta and Ochoa, 2002). This record is probably a mislabeling.

ECOLOGY: This species is endemic to the Queswa biogeographical region (Marín Moreno, 1961; Ceballos Bendezú, 1976; Ochoa, 2005; fig. 2B, C) and syntopic with two other bothriurids, *Brachistosternus andinus* and *Pachakutej oscari* Ochoa, 2004.

ACKNOWLEDGMENTS

We are grateful to Iván Benoit (Corporación Nacional Forestal del Gobierno de Chile, CONAF) for assistance with obtaining permits to collect scorpions in Chilean National Parks, to the CONAF staff at Pampa del Tamarugal National Park, and to the Dirección General Forestal y de Fauna Silvestre, Ministerio de Agricultura de Peru (ex-NRENA) for permits 061-2004-INRENA-IFFS-DCB, 002-2008-INRENA-IFFS-DCB, to collect scorpions in Peru. We thank John Achicahuala, Juan Carlos Chaparro, Luis Compagnucci, Roberto Gutiérrez, Paula Korob, Juan José Martinez, Daniel Muñiz, Williams Paredes, Luis Piacentini, Jaime Pizarro, Elias Ponce, Aarón Quiroz, J.L. Velasquez, Matías Vivanco, Ulrich Zanabria, and Horacio Zeballos for assisting us in the field; the following curators and collections managers for loaning and/or granting access to material from the collections in their care: Petra Sierwald and Alfred Newton (FMNH), František Kovařík (FKPC), Olintho Aguilar (MHNC), Gerardo Lamas and Diana Silva (MUSM), Alberto Chiarle (MRSN), and Hieronymus Dastych (ZMH); Luis Acosta for access to material on loan from MHNG; Wilfredo Mendoza (MUSM) for providing data on Peruvian vegetation; Ricardo Pinto da Rocha, Joyce Vitorino Villegas, Oscar Mujica, Horacio Larrain Barros, and Hugo Zamora for providing some of the photos of habitats and live habitus; Steve Thurston for assistance with preparing the plates; and two anonymous reviewers for comments on the manuscript. This research was supported by a Kalbfleisch Postdoctoral Research Fellowship from the AMNH, and a fellowship from the Fundação de Amparo à Pesquisa do Estado de São Paulo, Brazil (FAPESP 2010/00018-9) to J.A.O., grants from the Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina (CONICET) to A.A.O.A. and C.I.M., and a Genomics Postdoctoral Research Fellowship from the AMNH to C.I.M. Fieldwork in Chile was financially supported by the following sources: J.A.O., C.I.M. and L.P. (2003) from U.S. National Science Foundation grant EAR 0228699 to L.P.; J.A.O, C.I.M. and A.A.O.A. (2005) from the AMNH; A.A.O.A. (2006) from CONICET grant PIP 6502. Fieldwork in Peru (2008) was funded in part by a Kalbfleisch Postdoctoral Research Fellowship from the AMNH to J.A.O. Fieldwork in Argentina (2006, 2007) was financially supported by a CONICET grant PIP 6502 to A.A.O.A.

REFERENCES

Abalos, J.W. 1959. Scorpionida. Primeras Jornadas Entomoepidemiológicas Argentinas 2: 591–593.

Abalos, J.W. 1963. Scorpions of Argentina. *In* H.L. Keegan and W.V. MacFarlane (editors), Venomous and poisonous animals and noxious plants of the Pacific region: 111–117. New York: MacMillan.

Acosta, L.E. 1997. Descripcion de *Bothriurus olaen*, nueva especie de escorpión de Argentina central (Scorpiones: Bothriuridae). Revue Arachnologique 12 (1): 1–8.

Acosta, L.E. 2002. Case 3213. *Bothriurus alticola* Pocock, 1899. (Arachnida, Scorpiones): proposed precedence of the specific name over the subspecific name of *Cercophonius brachycentrus bivittatus* Thorell 1877. Bulletin of Zoological Nomenclature 59 (3): 176–179.

Acosta, L.E. 2005. Rediscovery of *Orobothriurus bivittatus* (Thorell 1877) stat. n., comb. n. in the Sierra del Tontal, Argentina (Scorpiones, Bothriuridae). Zootaxa 916: 1–15.

Acosta, L.E. 2006. Case 3332. *Cercophonius brachycentrus bivittatus* Thorell, 1877 (currently *Orobothriurus bivittatus*; Arachnida, Scorpiones): replacement of the holotype by the designation of a neotype. Bulletin of Zoological Nomenclature 63 (1): 20–22.

Acosta, L.E., and E.A. Maury. 1998. Scorpiones. *In* J.J. Morrone and S. Coscaron (editors), Biodiversidad de arthropodos argentinos. Una perspectiva biotaxonómica: 545–559. La Plata, Argentina: Ediciones Sur.

Acosta, L.E., and J.A. Ochoa. 2000. Nueva especie de *Orobothriurus*, Maury, del Perú. (Scorpiones, Bothriuridae). Revue Arachnologique 13 (10): 135–144.

Acosta, L.E., and J.A. Ochoa. 2001. Two new species of *Orobothriurus* Maury 1976, from Argentina and Peru, with comments on the systematics of the genus (Scorpiones, Bothriuridae). *In* V. Fet and P.A. Selden (editors), Scorpions 2001. *In memoriam* Gary A. Polis: 203–214. Burnham Beeches, Bucks: British Arachnological Society.

Acosta, L.E., and J.A. Ochoa. 2002. Lista de los escorpiones bolivia nos (Chelicerata: Scorpiones), con notas sobre su distribución. Revista de la Sociedad Argentina de Entomología 61 (3–4): 15–23.

Aguilar, P.G., and O. Meneses. 1970. Escorpiones y escorpionismo en el Perú I: Nota preliminar sobre los Scorpionida peruanos. Anales Científicos de la Universidad Nacional Agraria La Molina 8: 1–5.

Brack, A. 1986. Ecología de un país complejo. *In* Gran geografía del Perú. Naturaleza y Hombre 2, 175–319. Barcelona: Manfer-Juan Mejía Baca.

Bücherl, W. 1953. Quilópodos, aranhas e escorpiões enviados ao Instituto Butantan para determinaçao. Memórias do Instituto de Butantan 25 (1): 109–152.

Bücherl, W. 1959a. Escorpiones e escorpionismo no Brasil. VIII. Revisão das espécies do gênero *Bothriurus* descritas da Argentina. Memórias do Instituto Butantan 1957–58 28: 19–43.

Bücherl, W. 1959b. Escorpiones e escorpionismo no Brasil. X. Cátalogo dacoleção escorpiônica do Instituto Butantan. Memórias do Instituto Butantan 29: 255–275.

Bücherl, W. 1969. Giftige Arthropoden. *In* E.J. Fittkau, et al. (editors). Biogeography and ecology in South America (Monographiae Biologicae 19) 2: 764–793. Dordrecht: W. Junk.

Bücherl, W., et al. 1963. Escorpiões e escorpionismo no Brasil. XII. Revisão sistemática e crítica dos escorpiões do gênero *Bothriurus* Peters, 1861. Memórias do Instituto de Butantan 30: 207–226.

Byers, A.C. 2000. Contemporary landscape change in the Huascaran National Park and buffer zone, Cordillera Blanca, Peru. Mountain Research and Development 20 (1): 52–63.

Cabrera, A.L., and A.W. Willink. 1980. Biogeografía de América Latina. Serie de Biología, OEA Monographs vol. 13, 122 pp.

Caminos, R. 1999. Geología argentina. Buenos Aires: SEGEMAR, 796 pp.

Ceballos Bendezú, I. 1976. Nuevo esquema biogeográfico del Perú. Revista Universitaria, Universidad Nacional del Cusco 130: 19–44.

Cei, J.M. 1982. Aspetti geo-biogeografici inediti della Sierra di Famatina, il più elevato massiccio d'America del Sud dopo le cordigliere andine (Argentina centro-occidentale). L'Universo (Instituto Geografico Militare, Firenze) 62 (4): 643–672.

Cepeda-Pizarro, J. 2004. Ecología del paisaje de la Alta montaña del Valle de Elqui. La Serena: Ediciones Universidad de La Serena, 132 pp.

Cekalovic K., T. 1966. Contribución al conocimiento de los escorpiones chilenos. Museo Nacional de Historia Natural, Noticiario Mensual (Santiago) 10 (118): 1–8.

Cekalovic K., T. 1974. *Bothriurus dumayi* n. sp. de escorpión chileno (Scorpiones, Bothriuridae). Boletín de la Sociedad Biológica de Concepción 48: 209–216.

Coddington, J.A., and R.K. Colwell. 2001. Arachnids. *In* S.A. Levin (editor), Encyclopedia of biodiversity. Vol. 1, 199–218. San Diego, CA: Academic Press.

Dávila Flores, J. 1982. Escorpiones de las Lomas de Matarani – Islay. Actas 8vo Congreso Latinoamericano de Zoología, Merida, Venezuela:, 547–551.

Dupré, G. 2007. Conspectus Genericus Scorpionorum 1758–2006. Euscorpius 50: 1–31. (http://www.science.marshall.edu/fet/euscorpius/pubs.htm).

Fet, V., and M.E. Soleglad. 2005. Contributions to scorpion systematics. I. On recent changes in high-level taxonomy. Euscorpius 31: 1–13.

Flórez D., E. 2001. Escorpiones de la Familia Buthidae (Chelicerata: Scorpiones) de Colombia. Biota Colombiana 2 (1): 25–30.

Francke, O.F. 1974. Description of the male of *Bothriurus* (*Andibothriurus*) *peruvianus* Mello-Leitão (Scorpionida: Bothriuridae). Journal of Arachnology 1: 215–220.

Francke, O.F. 1977. Escorpiones y escorpionismo en el Peru VI: Lista de especies y claves para identificar las familias y los géneros. Revista Peruana de Entomología 20: 73–76.

Francke, O.F. 1985. Conspectus Genericus Scorpionorum 1758–1982 (Arachnida: Scorpiones). Occasional Papers of the Museum, Texas Tech University 98: 1–32.

Francke, O.F., and M.E. Soleglad. 1980. Two new *Hadruroides* Pocock from Peru (Scorpiones, Vaejovidae). Occasional Papers of the Museum, Texas Tech University 69: 1–13.

Gajardo, R. 1993. La vegetación natural de Chile, clasificación y distribución geográfica. Santiago de Chile: Editorial Universitaria, 165 pp.

Galiano, M.E., and E.A. Maury. 1979. Lista de los ejemplares típicos de Arachnida (Araneae, Opiliones, Scorpiones y Solifugae) depositados en el Museo Argentino de Ciencias Naturales "Bernardino Rivadavia." Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" Entomología 5 (11): 301–334.

Habit, M.A., D.T. Contreras, and R.H. González. 1981. *Prosopis tamarugo*: fodder tree for arid zones. FAO Plant Protection Paper 25. Rome: FAO.

Herrera, F.L. 1930. La vegetación de la costa peruana. Revista Universitaria, Universidad Nacional del Cusco 59 (1): 71–79.

International Commission on Zoological Nomenclature. 2008. Opinion 2191 (Case 3332). *Cercophonius brachycentrus bivittatus* Thorell, 1877 (currently *Orobothriurus bivittatus*; Arachnida, Scorpiones): proposed replacement of the holotype by the designation of a neotype not accepted. Bulletin of Zoological Nomenclature 65 (1): 69–70.

Kamenz, C., and L. Prendini. 2008. An atlas of book lung fine structure in the order Scorpiones (Arachnida). Bulletin of the American Museum of Natural History 316: 1–359.

Kovařík, F. 1998. Štiři (Scorpions). Jihlava: Madagaskar, 175 pp. [in Czech].

Kraepelin, K. 1911. Neue Beiträge zur Systematik der Gliederspinnen. Mitteilungen aus dem Naturhistorischen Museum (2. Beiheft zum Jahrbuch der Hamburgischen Wissenschafttlichen Anstalten, 1910) 28 (2): 59–107.

Lampe, E. 1917. Katalog der Skorpione, Pedipalpen und Solifugen des Naturhistorischen Museums der Residenzstadt Wiesbaden. Jahrbücher des Nassauischen Verein für Naturkunde 70 (1): 185–203.

Lomolino, M.V. 2001. Elevation gradients of species-density: historical and prospective views. Global Ecology and Biogeography 10: 3–13.

Lourenço, W.R. 1995. Les scorpions (Chelicerata, Scorpiones) de l'Équateur avec quelques considérations sur la biogéographie et la diversité des espèces. Revue Suisse de Zoologie 102 (1): 61–88.

Lourenço, W.R. 1997. Additions à la faune de scorpions neotropicaux. Revue Suisse de Zoologie 104 (3): 587–604.

Lourenço, W.R. 2002. Scorpiones. *In* J. Adis (editor), Amazonian Arachnida and Myriapoda: 399–438. Sofia-Moscow: Pensoft Publishers.

Lourenço, W.R. 2003. Scorpion biogeography: a review. *In* J.J. Morrone and J. Llorente Bousquets (editors), Una perspectiva latinoamericana de la biogeografía: 227–240. México, D.F.: Las Prensas de Ciencias, Facultad de Ciencias, UNAM.

Lourenço, W.R. 2005. Confirmation de la presence de la famille des Buthidae C.L. Koch, 1837 au Chili (Chelicerata, Scorpiones). Boletín de la Sociedad Entomológica Aragonesa 37: 109–112.

Lourenço, W.R., and H. Dastych. 2001. A contribution to the scorpion fauna of Peru, with a description of *Chactas koepckei* sp. nov. (Arachnida: Scorpiones). Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut 98: 51–62.

Lourenço, W.R., and E.A. Maury. 1985. Contribution à la connaissance systématique des scorpions appartenant au "complexe" *Tityus bolivianus* Kraepelin, 1895 (Scorpiones, Buthidae). Revue Arachnologique 6 (3): 107–126.

Lourenço, W.R., and J. Qi. 2006. Mountain scorpions: a new genus and species from Tibet (China). Comptes Rendus Biologies 329: 289–295.

Lowe, G., V. Fet, 2000. Family Bothriuridae Simon 1880. *In*, V. Fet, W.D. Sissom, G. Lowe, and M.E. Braunwalder, Catalog of the scorpions of the world (1758–1998):17–53. New York: New York Entomological Society.

Marín Moreno, F. 1961. Panorama fitogeográfico del Perú. Revista Universitaria, Universidad Nacional del Cusco 120: 9–68.

Masnú de Moreno, S.J. 1991. Aportes al estudio de la escorpiofauna mendocina. Revista del Museo de Historia Natural de San Rafael 11 (4): 169–200.

Mattoni, C.I., and L.E. Acosta. 2005. A new species of *Bothriurus* from Brazil (Scorpiones, Bothriuridae). Journal of Arachnology 33 (3): 735–744.

Mattoni, C.I., and L.E. Acosta. 2006. Systematics and distribution of three *Bothriurus* species (Scorpiones, Bothriuridae) from central and northern Chile. Studies on Neotropical Fauna and Environment 41 (3): 235–250.

Mattoni, C.I., J.A. Ochoa, A.A. Ojanguren-Affilastro, and L. Prendini. (in litt.) Reanalysis of the phylogeny of the Andean scorpion genus *Orobothriurus* (Scorpiones: Bothriuridae) phylogeny, Andean biogeography, and the relative importance of genitalic and somatic characters. Zoologica Scripta.

Maury, E.A. 1973. Sobre las especies de *Bothriurus* descriptas por F. Werner (Scorpiones: Bothriuridae). Neotropica 19 (59): 110–112.

Maury, E.A. 1975. Escorpiones y escorpionismo en el Perú IV: Revisión del género *Hadruroides* Pocock, 1893 (Scorpiones, Vaejovidae). Revista Peruana de Entomología 17 (1): 9–21.

Maury, E.A. 1976. Escorpiones y escorpionismo en el Perú V. *Orobothriurus*, un nuevo género de escorpiones altoandinos (Bothriuridae). Revista Peruana de Entomología 18 (1): 14–25.

Maury, E.A. 1978. Escorpiones y escorpionismo en el Perú VII. Nuevos hallazgos y redescripción de *Brachistosternus* (*Microsternus*) *andinus* Chamberlin, 1916 (Bothriuridae). Revista Peruana de Entomología 21 (1): 23–26.

Maury, E.A. 1979. Apuntes para una zoogeografía de la escorpiofauna Argentina. Acta Zoológica Lilloana 35 (2): 703–719.

Maury, E.A. 1980. Usefulness of the hemiespermatophore in the systematics of the scorpion family Bothriuridae. *In* J. Gruber (editor), Verhandlungen. 8. Internationaler Arachnologen-Kongress Abgehalten ander Universität für Bodenkultur Wien, 7–12 Juli, 1980:335–339. Vienna: H. Egermann.

Maury, E.A. 1981. Estudio sobre el género *Bothriurus* (Scorpiones, Bothriuridae). I. Catálogo y comentarios sobre el material típico. Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" Entomología 4 (4): 95–111.

Maury, E.A. 1984. Redescripción de *Bothriurus bocki* Kraepelin, 1911 (Scorpiones, Bothriuridae). Journal of Arachnology 12 (3): 351–356.

Mello-Leitão, C. de. 1931. Notas sôbre os Bothriuridae Sul-Americanos. Arquivos do Museu Nacional 33: 75–105.

Mello-Leitão, C. de. 1932. Notas sôbre escorpiões Sul-Americanos. Arquivos do Museu Nacional 34: 9–46.

Mello-Leitão, C. de. 1934. Estudo monográfico dos Escorpiões da Republica Argentina. Octava Reunión de la Sociedad Argentina de Patología Regional: 1–97.

Mello-Leitão, C. de. 1935. On two Brasilian scorpions. Revista Chilena de Historia Natural 39: 90–93.

Mello-Leitão, C. de. 1937. Dois escorpiões Sul-Americanos. Annaes da Academia Brasileira de Ciências 9 (2): 99–104.

Mello-Leitão, C. de. 1938. Notas sobre alacranes argentinos. Notas del Museo de La Plata, Zoología 3 (9): 83–95.

Mello-Leitão, C. de. 1939. Les arachnides et la zoogeographie de l'Argentine. Physis 17 (49): 601–630.

Mello-Leitão, C. de. 1945. Escorpiões sul-americanos. Arquivos do Museu Nacional, Rio de Janeiro 40: 7–468.

Mello-Leitão, C. de. 1948. In: Mello-Leitão, C. De, and J. de Araújo Feio. 1948. Notas sôbre pequeña colecção de Aracnídeos do Perú. Boletim do Museu Paraense Emilio Goeldi 10: 313–324.

Ochoa, J.A. 2004a. Filogenia del género *Orobothriurus* y descripción de un nuevo género de Bothriuridae (Scorpiones). Revista Ibérica de Aracnología 9: 43–73.

Ochoa, J.A. 2004b. *Brachistosternus ninapo* una nueva especie (Scorpiones: Bothriuridae) de los Andes occidentales en el sur del Perú. Revista Peruana de Biología 11 (2): 139–148.

Ochoa, J.A. 2005. Patrones de distribución de escorpiones de la región andina en el sur peruano. Revista Peruana de Bi-ología 12 (1): 49–68.

Ochoa, J.A., and L.E. Acosta. 2002a. *Orobothriurus atiquipa*, a new bothriurid species (Scorpiones) from Lomas in southern Peru. Journal of Arachnology 30: 98–103.

Ochoa, J.A., and L.E. Acosta. 2002b. Two new Andean species of *Brachistosternus* Pocock (Scorpiones: Bothriuridae). Euscorpius 2: 1–13.

Ochoa, J.A., and L.E. Acosta. 2003. Una nueva especie de *Orobothriurus* del Santuario Nacional de Ampay, Apurimac, Perú. Revista Peruana de Entomología 43: 1–6.

Ochoa, J.A., and J.C. Chaparro. 2008. Nueva especie de escorpión del género *Hadruroides* (Scorpiones: Caraboctoninae) de los valles interandinos de Peru. Revista Peruana de Biología 15 (1): 5–10.

Ochoa, J.A., and L. Prendini. 2010. The genus *Hadruroides* Pocock, 1893 (Scorpiones: Iuridae), in Peru: new records and descriptions of six new species. American Museum Novitates 3687: 1–56.

Ochoa, J.A., R. Botero-Trujillo, and L. Prendini. 2010. On the troglomorphic scorpion *Troglotayosicus humiculum* (Scorpiones, Troglotayosicidae), with first description of the adults. American Museum Novitates 3691: 1–19.

Ojanguren Affilastro, A.A. 2002. *Brachistosternus galianoae* (Scorpiones, Bothriuridae) una nueva especie de Bolivia. Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" 4: 105–109.

Ojanguren Affilastro, A.A. 2003a. Un nuevo *Orobothriurus* (Scorpiones, Bothriuridae) de la region de Atacama, Chile. Revista Ibérica de Aracnología 7: 117–122.

Ojanguren Affilastro, A.A. 2003b. Las especies andinas del género *Brachistosternus* (*Leptosternus*) con la descripción de tres nuevas especies. Revista Ibérica de Aracnología 8: 23–36.

Ojanguren Affilastro, A.A. 2004. Sistemática y distribución de *Brachistosternus* (*Leptosternus*) *intermedius* Lönnberg. (Scorpiones, Bothriuridae). Physis (Buenos Aires), Sec. C 59: 29–35.

Ojanguren Affilastro, A.A. 2005. Estudio monográfico de los escorpiones de la República Argentina. Revista Ibérica de Aracnología 11: 75–241.

Ojanguren Affilastro, A.A., and C.I. Mattoni. 2006. A new species of *Brachistosternus* from the Chilean central Andes (Scorpiones: Bothriuridae). Studies on Neotropical Fauna and Environment 41 (1): 79–85.

Ojanguren Affilastro, A.A., P. Agusto, J. Pizarro Araya, and C.I. Mattoni. 2007a. Two new scorpion species of genus *Brachistosternus* (Scorpiones: Bothriuridae) from northern Chile. Zootaxa 1623: 55–68.

Ojanguren Affilastro, A.A., C.I. Mattoni, and L. Prendini. 2007b. The genus *Brachistosternus* (Scorpiones: Bothriuridae) in Chile, with descriptions of two new species. American Museum Novitates 3564: 1–44.

Ojanguren Affilastro, A.A., F. Fernández Campón, S. Lagos Silnik, and C.I. Mattoni. 2009. The genus *Orobothriurus* Maury in central Argentina with the description of a new species from El Nevado mountain chain in Mendoza (Scorpiones: Bothriuridae). Zootaxa 2209: 28–42.

Ojanguren Affilastro, A.A., and M.J. Ramírez. 2009. Phylogenetic analysis of the scorpion genus *Brachistosternus* (Arachnida, Scorpiones, Bothriuridae). Zoologica Scripta 38 (2): 183–198.

Péfaur, J.E. 1981. Composition and phenology of epigeic animal communities in the Lomas of southern Peru. Journal of Arid Environments 4: 31–42.

Pocock, R.I. 1899. Scorpions and spiders. *In* E.A. FitzGerald (editor), The highest Andes: 356–358. London: Methuen.

Polis, G.A. 1990. Ecology. *In* G.A. Polis (editor), The biology of scorpions: 247–293. Stanford, CA: Stanford University Press.

Prendini, L. 2000. Phylogeny and classification of the superfamily Scorpionoidea Latreille 1802 (Chelicerata, Scorpiones): an exemplar approach. Cladistics 16: 1–78.

Prendini, L. 2003. A new genus and species of bothriurid scorpion from the Brandberg Massif, Namibia, with a reanalysis of bothriurid phylogeny and a discussion of the phylogenetic position of *Lisposoma* Lawrence. Systematic Entomology 28: 149–172.

Prendini, L. 2004. The systematics of southern African *Parabuthus* Pocock (Scorpiones, Buthidae): revisions to the taxonomy and key to the species. Journal of Arachnology 32: 109–186.

Prendini, L. 2006. Scorpiones. *In* McGraw-Hill encyclopedia of science and technology. Access Science@McGraw-Hill. Available online (http://www.accessscience.com). [doi 10.1036/1097-8542.607800]

Prendini, L., and W.C. Wheeler. 2005. Scorpion higher phylogeny and classification, taxonomic anarchy, and standards for peer review in online publishing. Cladistics 21: 446–494.

Rein, J.O. 2007. Taxonomic updates in scorpions (Arachnida: Scorpiones) since the publication of the Catalogue of the Scorpions of the World (1758–1998) (Fet, Sissom, Lowe, and Braunwalder, 2000). Part 1: Bothriuridae. The Scorpion Files Occasional Papers 1: 1–12, Available online (http://www.ub.ntnu.no/scorpion-files/sf_occationalpapers.php).

Roig Alsina, A. 1973. Fauna y ecosistema del oeste arido argentino. III. Escorpiofauna de la provincia de Mendoza. Deserta 4: 195–208.

Roig Alsina, A. 1977. Una nueva especie de escorpión andino de Mendoza, República Argentina (Bothriuridae). Physis Sección C 37 (93): 255–259.

Serra, M.T. 1997. *Prosopis tamarugo*. FAO RLC Agroforestería – Arboles en zonas áridas. FAO, Santiago.

Sissom, W.D. 1990. Systematics, biogeography and paleontology. *In* G.A. Polis (editor), The biology of scorpions, 64–160. Stanford, CA: Stanford University Press.

Soleglad, M.E., and V. Fet. 2003. High-level systematics and phylogeny of the extant scorpions (Scorpiones: Orthosterni). Euscorpius 11: 1–172.

Squeo, F.A., R. Osorio, and G. Arancio. 1994. Flora de Los Andes de Coquimbo: Cordillera de Doña Ana. La Serena: Ediciones Universidad de La Serena, 168 pp.

Stahnke, H.L. 1970. Scorpion nomenclature and mensuration. Entomological News 81: 297–316.

Stahnke, H.L. 1972. U.V. light, a useful field tool. BioScience 22 (10): 604–607.

Thorell, T. 1877 [1876]. Études scorpiologiques. Atti della Società Italiana di Scienze Naturali 19: 75–272.

Vachon, M. 1952. Étude sur les Scorpions. Alger: Institut Pasteur d'Algérie, 482 pp.

Vachon, M. 1973 [1974]. Étude des caractères utilisés pour classer les familles et les genres de scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriaux et types de trichobothriotaxie chez les scorpions. Bulletin du Muséum National d'Histoire Naturelle (Paris) Ser. 3 140: 857–958.

Werner, F. 1916. Ueber einige Skorpione und Glieder-spinnen des Naturhistorischen Museums in Wiesbaden. Jahrbücher des Nassauischen Vereins für Naturkunde 69: 79–97.

APPENDIX 1

CHECKLIST OF TAXA ASSIGNED TO *OROBOTHRIURUS* MAURY, 1976, AT VARIOUS TIMES

Bothriurus dumayi Cekalovic, 1974: transferred to *Orobothriurus* by Maury (1976) and returned to *Bothriurus* Peters, 1861, by Acosta and Ochoa (2001).

Bothriurus lampei Werner, 1916: synonymized with *O. curvidigitus* by Maury (1973).

Cercophonius brachycentrus var. β *bivittatus* Thorell, 1877: transferred to *Orobothriurus* by Acosta (2002), elevated to species (*Orobothriurus bivittatus*) by Acosta (2005), and synonymized with *O. alticola* by Ojanguren Affilastro et al. (2009).

Orobothriurus alticola (Pocock, 1899): originally described as *Bothriurus alticola* Pocock, 1899, and transferred to *Orobothriurus* by Maury (1976), becoming type species of the genus.

Orobothriurus ampay Ochoa and Acosta, 2003.

Orobothriurus atiquipa Ochoa and Acosta, 2002.

Orobothriurus calchaqui, n. sp.

Orobothriurus compagnuccii, n. sp.

Orobothriurus curvidigitus (Kraepelin, 1911): originally described as *Bothriurus curvidigitus* Kraepelin, 1911, and transferred to *Orobothriurus* by Maury (1976).

Orobothriurus famatina Acosta, 2001.

Orobothriurus grismadoi Ojanguren Affilastro et al., 2009.

Orobothriurus huascaran, n. sp.

Orobothriurus lourencoi Ojanguren Afillastro, 2003: although currently placed in *Orobothriurus*, this species will be placed in another genus (Mattoni et al., in litt.).

Orobothriurus paessleri (Kraepelin, 1911): originally described as *Bothriurus paessleri* Kraepelin, 1911, and transferred to *Orobothriurus* by Maury (1976).

Orobothriurus parvus Maury, 1976: previously misidentified as *Bothriurus borellianus* Mello-Leitão, 1934, *Bothriurus chilensis* (Molina, 1782), and *Bothriurus peruvianus* Mello-Leitão, 1948, by Bücherl, 1959b; Aguilar and Meneses, 1970; and Francke, 1974, respectively.

Orobothriurus quewerukana, n. sp.: confused with *Bothriurus dumayi* by Maury (1976).

Orobothriurus ramirezi, n. sp.

Orobothriurus tamarugal, n. sp.

Orobothriurus wawita Acosta and Ochoa, 2000.

Pachakutej crassimanus (Maury, 1976): originally described as *Orobothriurus crassimanus* Maury, 1976, transferred to *Pachakutej* by Ochoa (2004a).

Pachakutej inca (Maury, 1976): originally described as *Orobothriurus inca* Maury, 1976, transferred to *Pachakutej* by Ochoa (2004a).

Pachakutej iskay (Acosta and Ochoa, 2001): originally described as *Orobothriurus iskay* Acosta and Ochoa, 2001, and transferred to *Pachakutej* by Ochoa (2004a).

Pachakutej peruvianus (Mello-Leitão, 1948): originally described as *Bothriurus peruvianus* Mello-Leitão, 1948, transferred to *Orobothriurus* by Maury (1976), and to *Pachakutej* by Ochoa (2004a).

APPENDIX 2

LIST OF 65 CHARACTERS SCORED FOR 15 SPECIES OF *OROBOTHRIURUS* MAURY, 1976, AND 15 OUTGROUP TAXA, FROM MATTONI ET AL. (IN LITT.)

Character states are scored 0–3, unknown (?) and inapplicable (-). Characters from previous analyses that correspond partially or entirely to those in the present matrix are as follows: O2004 = Ochoa (2004a); OA&R2009 = Ojanguren Affilastro and Ramírez (2009); P2003 = Prendini (2003).

Pigmentation pattern

0. Tergites I–IV, pigmentation: entirely pigmented (0); paired spots sublaterally, unpigmented area medially (1) [O2004: 0; OA&R2009: 1].
1. Tergite VII, pigmentation: entirely pigmented (0); paired spots sublaterally, unpigmented area medially (1); inapplicable (-).
2. Metasomal segments II and III, dorsal surfaces, pigmentation: absent, unpigmented (0); subtriangular spot medially, it may be divided by unpigmented line medially (1).
3. Metasomal segments I–III, dorsal surfaces, pigmentation along DL carinae: absent, unpigmented (0); reticulate lines (1).
4. Metasomal segments IV and V, ventral surfaces, VM stripe: contiguous with VL stripe posteriorly (0); not contiguous with VL stripe posteriorly (1); absent (2). [OA&R2009: 5].
5. Telson vesicle, ventral and lateral surface, coloration (♂): similar to ♀, pigmented (0); different from ♀, unpigmented, with glandular, light yellow coloration (1).

Carapace

6. Anterior margin, shape: sublinear or with shallow median notch (0); with weak median projection (epistome) (1). [OA&R2009: 7].
7. Anteromedian longitudinal sulcus, length (♂): complete (0); vestigial (1). [P2003: 4; O2004: 1; OA&R2009: 8].

Chelicera

8. Movable finger, subdistal teeth, number: one (0); two (1). [P2003: 9; O2004: 2; OA&R2009: 6].

Pedipalps

9. Femur, length (♂): greater than three times width (0); less than three times width (1). [O2004: 3; OA&R2009: 75].
10. Femur, dorsal surface, shape: slightly convex, DE and DI carinae situated in different axes (0); flat, DE and DI carinae situated in same axis (1). [O2004: 4].
11. Chela, shape: similar in both sexes or narrower (length/width ratio of pedipalp chela smaller) in ♂ than ♀ (0); more robust (length/width ratio of

pedipalp chela greater) in ♂ than ♀ (1). [O2004: 5; OA&R2009: 60].
12. Chela manus, external surfaces, shape (♂): prismatic (0) flat (1). [O2004: 6].
13. Chela manus, surfaces adjacent to DMA carinae, shape (♂): D–DMA–DI carinae forming angle greater than 90° (0); D–DMA–DI carinae forming angle less than 90°. [O2004: 7].
14. Chela manus, DMA, DI and VM carinae, granulation (♂): absent, smooth (0); present, finely and densely granular (1).
15. Chela movable finger, shape (♂): straight (0); curved (1). [O2004: 8].
16. Chela manus, secondary sexual apophysis (♂): present (0); absent (1). [O2004: 9].
17. Chela manus, secondary sexual apophysis, shape (♂): conical (0); spiniform (1); lobate (2); conical-truncate (3); hornlike (4); inapplicable (-). [P2003: 25; O2004: 10; OA&R2009: 61].
18. Chela manus, secondary sexual apophysis, position (♂): close to base of fixed finger, distal to trichobothrium *ib* (0); in distal third of manus, proximal to trichobothrium *ib* (1).
19. Chela fixed finger, group of granules at base (♂): absent (0); present (1). [P2003: 26; O2004: 11; OA&R2009: 62].
20. Chela fingers, median denticle rows, number: single row (0); multiple rows (1). [P2003: 27; O2004: 12; OA&R2009: 64].
21. Chela movable finger, median denticle row, relative denticle size: all denticles equal in size (0); basal denticle greatly enlarged, approximately five times larger than other denticles (1).

Trichobothria

22. Chela manus, trichobothrium *ib*, position (♂): situated at base of ventral side of secondary sexual apophysis, visible in ventral view (0); situated at base of internal side of apophysis, not visible in ventral view (1); situated more distal to apophysis, visible in ventral view (2). [O2004: 13].
23. Chela manus, trichobothrium *Esb*, position: intermediate between Eb_1 and Eb_2 (0); dorsal to Eb_2 (1); intermediate between Eb_2 and Eb_3 (2). [O2004: 14; OA&R2009: 53].
24. Chela manus, trichobothrium Et_3, position: distal to *Est* (0); in same axis as *Est* (1); proximal to *Est* (2). [O2004: 15; OA&R2009: 54].
25. Chela manus, trichobothrium V_2, position: forming obtuse angle (< 180°) with V_1 and V_3 (0); in same axis as V_1 and V_3 (1). [O2004: 16].
26. Chela fixed finger, trichobothrium *dst*, position: in same axis as *est* (0); proximal to *est* (1). [O2004: 17].
27. Chela manus, trichobothrium *Db*, position: close to *Dt* (0); equidistant between *Dt* and Eb_3 (1). [O2004: 18].
28. Chela manus, trichobothrium Et_5, position: forming acute angle (< 90°) with *eb* and Et_4 (0); forming obtuse angle (< 180°) with *eb* and Et_4 (1). [O2004: 19].

Legs

29. Legs III and IV, telotarsi, ventrosubmedian spiniform macrosetae, number of pairs: three (0); more than five (1). [O2004: 20; OA&R2009: 39].

Genital operculum

30. Genital sclerites, shape (♀): rhomboid (0); posteriorly elongated, anterior edge slightly rounded (1).

Sternites and Metasoma

31. Sternite VII, carinae: absent (0); VL and/or VSM carinae present (1). [O2004: 21; OA&R2009: 81].
32. Metasomal segment I, VSM carinae (♀): absent (0); present (1). [O2004: 22; OA&R2009: 91].
33. Metasomal segment II, VSM carinae (♀): present (0); absent (1). [O2004: 23; OA&R2009: 92].
34. Metasomal segment II, VSM carinae (♂): present (0); absent (1). [O2004: 24].
35. Metasomal segment III, VSM carinae (♀): present (0); absent (1). [O2004: 25].
36. Metasomal segment IV, VSM carinae (♀): present (0); absent (1). [O2004: 26; OA&R2009: 97].
37. Metasomal segment IV, VSM carinae (♂): present (0); absent (1). [O2004: 27].
38. Metasomal segment V, VL carinae (♂): present in more than half of segment (0); restricted the posterior third (1); absent or reduced to few granules posteriorly (2). [O2004: 28; OA&R2009: 104].
39. Metasomal segment V, VL and VSM carinae, relative orientation: well separated, diverging (0); adjacent, subparallel (1); inapplicable (-). [O2004: 29].
40. Metasomal segment V, VSM carinae, orientation in posterior third: subparallel, not diverging (0); diverging slightly (1), diverging strongly, forming arc (2). [P2003: 82; O2004: 30; OA&R2009: 101; additive].
41. Metasomal segment V, VM carina: present, well developed (0), vestigial or absent (1). [O2004: 31].
42. Metasomal segment III, length (♂): less than or equal to width (0); greater than width (1). [O2004: 32; OA&R2009: 105].
43. Metasomal segment V, length (♂): less than or equal to twice width (0); greater than twice width (1). [O2004: 33; OA&R2009: 106].

Macrosetae

44. Pedipalp femur, dorsal macroseta (M_1) situated near *d* trichobothrium: present (0), absent (1). [O2004: 34].
45. Metasomal segment I, VSM macrosetae, number of pairs: two (0); three (1). [O2004: 35; OA&R2009: 83].
46. Metasomal segment III, VSM setae, number of pairs: two (0); three (1). [O2004: 36].
47. Metasomal segment IV, VSM setae, number of pairs: two (0); three (1); four (2). [O2004: 37; OA&R2009: 87; additive].

Hemispermatophore

48. Apex of lamina, shape of distal margin: sub triangular (0); rounded or subquadrangular (1). [O2004: 38].
49. Apex of lamina, length: greater than length of frontal crest (0); less than length of frontal crest (1); inapplicable (-).
50. Distal crest, shape: curved with respect to ventral border (0); parallel to ventral border (1); straight and diagonal to ventral border (2). [O2004: 40].
51. Semicircular depression at base of lamina, development: well developed, extended to basal

portion (0); slightly developed (1); obsolete (2). [O2004: 41; additive].

52. Posterodistal fold: absent (0); present (1). [O2004: 42].
53. Frontal crest: absent (0); present (1). [O2004: 43; OA&R2009: 35].
54. Frontal crest, incision in distal border: absent (0); present (1); inapplicable (-). [O2004: 44].
55. Frontal crest, shape: undivided, with continuous, smooth borders, without undulations (0); divided in two parts, proximal oblique part with two lateral folds, distal part straight usually parallel to ventral margin of lamina, with lateral projections on each side (1); divided in two parts, distal part sinuous with strong undulation in dorsal border (2).; inapplicable (-). [O2004: 45].
56. Frontal crest, lateral projections of distal part, shape: reduced, length of projections less than length of proximal oblique part (0); elongated, length of distal part greater than proximal oblique part (1); inapplicable (-). [O2004: 47].
57. Capsule, internal lobe, development: similarly developed to external lobe (0); considerably more developed than external lobe (1). [O2004: 49].
58. Capsule, internal lobe, spiniform apophysis on external surface: absent (0); present (1). [O2004: 50].
59. Capsule, internal lobe, sclerotized apophysis on internal fold: absent (0); present (1). [O2004: 51].
60. Capsule, basal lobe, tortuous stem, subdistal spatulate dilation ending in terminal process: absent (0); present (1). [O2004: 52].
61. Capsule, basal lobe, subdistal dilation, shape: widened (0); oval (1); elongated (2); inapplicable (-). [O2004: 53].
62. Capsule, basal lobe, terminal process, shape: short (0); elongated (1); inapplicable (-). [O2004: 54].
63. Capsule, basal lobe, spatulate terminal process: absent (0); present (1). [O2004: 55].
64. Capsule, basal lobe, papillose fold: absent (0); present (1). [O2004: 56].